AIR ENGINEERING

VOL. 1, NO. 7

OCTOBER, 1959

DEDICATED TO THE SCIENCE OF AIR POLLUTION CONTROL
AIR MOVING • AIR CONDITIONING

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COVER

For this striking representation of the filtration process, one of the basic elements of air engineering, we are indebted to Flanders Filters, Inc. of Riverhead, N. Y.

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New Appointments

Research-Cottrell, Inc. has appointed **Bruno Gruenwald** as special project engineer for mechanical dust collectors. In this capacity he will coordinate sales and service of Cyclotrells and related equipment including the recently announced involute type as well as the multiple tubular design. He has had 11 years' experience in dust collection.

B. Gruenwald

The Trane Co. has recently appointed new managers in Dayton, Salt Lake City, and Atlanta.

J. R. Patterson heads the Dayton office after serving in the company's Indianapolis office since 1955.

Charles E. Warren assumes management of the Salt Lake City office after working there as a salesman since 1954.

E. Milton Bevington, new head of the Atlanta office, has worked in the field of air conditioning sales since 1956.

Appointment of **Peter A. McLeod** as field sales manager of the Air Conditioning and Refrigeration Div. of Worthington Corp. was announced by A. J. Hackl, general manager. McLeod was formerly manager of product sales.

Paul C. Venable was named assistant manager, national account sales, and **Vincent G. Weigers,** manager of manufacturing at Holyoke, Mass., Venable's former position. Weigers was staff assistant to W. J. Millett, manager of manufacturing.

C. W. Reed Co., Los Angeles, now represents the Gelman Instrument Co. in the 11 western states.

Appointment of **John E. Gabrielson** as sales engineer in Salt Lake City has been announced by H. E. Beane, vice president of sales for the Bristol Co.

Gabrielson, with the company since 1956, was formerly with Bristol's application engineering department at the home office in Waterbury, Conn. He will serve Salt Lake City and the Idaho Falls area.

James W. Wilcock has been appointed manager of the Sturtevant Div. of Westinghouse Electric Corp., it was announced by H. E. Seim, Westinghouse vice president in charge of the division.

J. W. Wilcock

Wilcock has served as marketing manager of the division since January, 1956.

In 1958, Wilcock served as president of the Air Moving and Conditioning Association, and presently is a vice president and director.

Air Conditioning Supply Co., Los Angeles, has opened a new branch office to serve the San Diego sector, it was announced by Lind Davenport, president.

The firm will represent Drayer-Hanson's air conditioning products in greater San Diego. Appointed as sales engineer there is **Roy Graser,** who joined Air Conditioning Supply directly from a 5½-year association with Drayer-Hanson as sales application engineer.

DuBois-Webb Co., Inc., Detroit, has been appointed sales representative for Desomatic Products, Inc., manufacturer of commercial dehumidifiers and air dryers. DuBois-Webb has appointed **Ralph E. Cranston, Walter A. Stoye,** and **Melvin R. McBride** to its sales staff.

Appointment of **A. H. Reando** as manager of refrigeration sales for the Presstite Div., American-Marietta Co., has been announced by J. R. Moore, vice president in charge of sales.

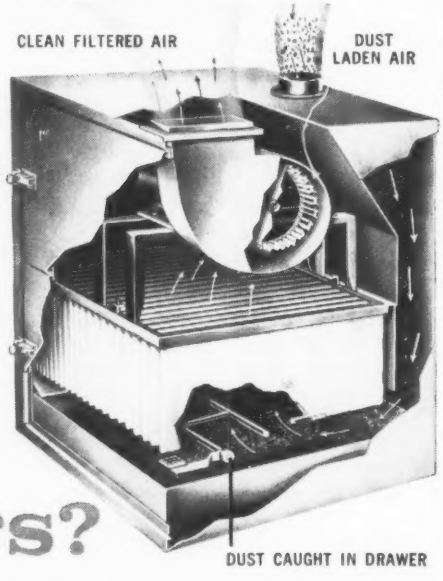
Reando served as supervisor in the Presstite quality control laboratory prior to joining the sales department. He has been with the Presstite company for 10 years.

George R. Beidler has been appointed territorial manager of the Atlanta sales office of Dravo Corp. He will supervise the sale of Dravo's line of industrial space heaters and Dravo Welded and Pressure-Locked grating and stair treads in 14 southern states.

Most recently Beidler was southwest territorial manager for Dravo with offices in Dallas.

have you got the facts on money-saving preventive maintenance with

Torit dust collectors?



Clean machines hold close tolerances *better* and *up to 80% longer*. Result: a measurable saving in both the cost and frequency of servicing and maintenance work. You can protect your client's plant and equipment investment, help reduce potential production breakdowns, by specifying TORIT Dust Collectors. In the cabinet type (illustrated by cutaway drawing) filters are rated 99.99% efficient by weight on particles as small as ½ micron! Compact Torit high efficiency cyclone and cabinet type units are designed to save space, install anywhere. Your Torit representative will gladly give you dust collector specifications, performance charts, dimensional drawings and installation suggestions. Write:

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AIR ENGINEERING Newsletter

AIR POLLUTION CONTROL • AIR MOVING • AIR CONDITIONING

Return To The City + Air Pollution = Air Conditioning

The trend toward return to the city from suburbia, plus plans to end urban blight, have upped interest in air conditioning the whole housing site, (house *plus* lot) according to distinguished Boston architect Carl Koch.

At a seminar on air conditioned living, Koch said that "The air in many of our major cities is simply not fit to breathe and we are still laboring under the delusion that opening the window lets in fresh, healthful air.

"With air conditioning we can make it possible to eliminate odors, virus, bacteria, radioactive materials and other contaminants. Air pollution was one of the reasons we moved out of town to begin with."

Air conditioning, he concluded, may be a dominant factor in halting America's population march to the suburbs and attracting families back to the city.

AEC Announces Method of Removing Strontium 90 from Milk

Using a technique similar to that employed in water softeners, the Atomic Energy Commission reports that it has been possible to remove up to 94 percent of the strontium from skim milk, without loss of calcium.

Strontium has also been removed from cream by repeated dilutions with water followed by separations.

The commission emphasized that these techniques were still in the preliminary laboratory stage and that further work is necessary to determine their feasibility on a large scale.

In the same report, the AEC stated that radioactive fallout from nuclear tests finally showed a decline in May and June of this year, after gradually rising due to the intensive atom testing series in 1958.

Is Air Conditioning Growing Faster Than Power Supply?

Another power plant was knocked out of service, this time in Milwaukee.

A few weeks ago New Yorkers in a sizable portion of uptown Manhattan were deprived of electricity due to the burnout of overloaded underground cables. Air conditioning was blamed, in large measure, for the overload.

Now, as we approach presstime, comes a report from Milwaukee that the power generating capacity of that city's Oak Creek station has been strained to near overload capacity, with air conditioning again marked out as the major source of the additional current consumption.

Fans To Be Kept Cool At Crosley Field

Home of the fifth place Cincinnati Reds, Crosley Field, will be one of the coolest spots in town by 1960. The ball park will have a completely air conditioned grandstand (both upper and lower decks).

Fans liked the portion of the grandstand that was air conditioned last year so much that the ball club decided to add more jet fans, more capacity to cool the entire grandstand. At present writing the Redlegs have the only air-cooled park in the major leagues.

New 'Prefab' Smoke Stack

A new prefabricated refractory smokestack for commercial and industrial boilers, furnaces and incinerators has been announced by Van-Packer Co., Div. of Flintkote Co.

Set Timetables To Correct Air Pollution Problems For Foundries and Asphalt Plants In N.Y. City Area

Surveys on the air pollution problems of foundries and asphalt plants in New York City have been completed, reports the N.Y. Air Pollution Control Department. The program included studies by Department engineers, conferences between industry and Department representatives, and establishment of timetables for correction.

An improvement program for the Tully and DiNapoli asphalt plant was completed in 1958, at a cost of approximately $50,000, it was reported. Also, the Borough president of Brooklyn has undertaken a program for the installation of a dust collecting system in the city's Brooklyn asphalt plant.

Refinery Spends $1 for Every $8 To Combat Nuisances

Cities Service Co.'s new $27 million refinery near Toronto, Canada, embodies $3 million worth of such "good neighbor" features – or for every eight dollars spent in actual construction, an additional dollar was spent to eliminate such community nuisances as noise, traffic, smog, and water pollution.

Oil Industry Says $1 Million a Year Goes to Pollution Research

"Since 1956, the petroleum industry has spent more than $66 million for air pollution control and now is spending $1 million a year in research on methods for preventing harmful gases from escaping from refineries."

So states William J. Carthaus, Tulsa, Okla., president of the Western Petroleum Refiners Association, in a statement denying the charges of Dr. Leroy E. Burney, surgeon general of the U.S., who has allegedly charged that petroleum refiners are the only major industry not cooperating on air pollution control.

Market Begs for Blowers

Here's a ready-made market for a big blower order. It's the underwater tunnel between Long Island City and Manhattan used by New York's IRT subway system. The old tunnel has no forced ventilation, depends on train movement to push stale air along. As long as trains move, nothing much happens.

But let a train stall and tragedy could be the result. It almost happened recently when not one, but two trains stalled and passengers were in danger of suffocation from a trackside fire.

Air Conditioning Removes Fumes at Gulf Research

A major portion of the more than 1,500 employees in Gulf Research & Development Co. laboratories in Harmarville, Pa. will work in air conditioned facilities when an air conditioning project for the research center is completed. Systems are being so designed that a high volume of exhaust air will carry off fumes generated in laboratory experiments with petroleum products.

Two Carrier absorption machines, of 236-ton cooling capacity each, will use steam to produce chilled water for air conditioning units installed in parts of five major laboratory buildings and several smaller structures. Rather than mar the research center's campus-like atmosphere, the absorption machines will be placed in an underground vault and covered with landscaping. From this centrally located refrigerating plant, chilled water for cooling will be piped through subterranean passages, which are also used as all-weather walkways by laboratory personnel.

AIR ENGINEERING

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EDITORIAL:

Hospital Air Conditioning Registers Another Good Deed Indeed For Air Engineering

PERHAPS NO OTHER APPLICATION of air conditioning (which is a vital part of the total concept of AIR ENGINEERING) has such immediately useful effect on human health as does hospital air conditioning.

Its salubrious effects on heart patients have been noted by physicians and surgeons over and over again. Its usefulness in treating victims of respiratory affections, likewise.

Now comes a new demonstration of air conditioning's filtered power to protect human health and, actually, to save lives.

When "miracle" germ-killers first appeared (the sulfas, penicillin, aureomycin and a host of other drugs) streptococcus infection was the most feared resistant disease in hospitals everywhere.

Currently *staphylococcus aureus* (which spreads through hospitals wildly unless extreme precautions are taken by all hands from porter to patient) is the big problem.

Post-operative patients, along with premature and new-born infants, are principal victims of this in-hospital-scourge.

Obvious steps toward establishing ideally aseptic conditions aren't enough. High standards of hospital cleanliness do aid, *but can't stop,* spread of the staph bugs.

These animalcules float through the air with the greatest of ease aboard droplets of moisture (aerosols) or on dust particles. Upon encountering human flesh, they clamp onto and impinge into fresh wounds of surgical cases. They also are inhaled by newly-born babies.

Therefore, hospital air conditioning not only is necessary. Suddenly it has become *urgent* . . . to filter and otherwise sterilize sick air. To purge air in hospitals from staph and other dread-spread airborne bacteria, complete air conditioning has become a "must."

In use now (and proving helpful) are such adjuncts as ultra-violet lamps at Beverly Hills' Mt. Sinai Hospital and at the VA Hospital at Livermore (both in California); chemically coated filters which trap and kill germs at a New York City hospital; lithium chloride wash (see page 24, April issue); and effi-

(Please turn to following page)

NEWS of the Industry

Pittsburgh Hails Pollution Progress

Air pollution control methods have had the leading part in the "tremendous improvement" that has been made in cleaning up the atmosphere in Pittsburgh, and is the key to "the long way still to go" in obtaining a satisfactory level of atmospheric purity.

So stated Lee Schreibeis, acting chief of the Allegheny County Bureau of Air Pollution Control.

"Since the advent of the smoke control law," Schreibeis reported, "two large central heating plants have replaced approximately 700 small heating plants in the heart of the Pittsburgh district. The central heating stations are equipped with collectors and other facilities to reduce smoke and fly ash emissions to a minimum.

"In 1958, out of a possible discharge of 11,750 tons, these two plants collected 11,224 tons of ash and fly ash, representing a 95.6 percent collection efficiency.

"Discharge of solids into the air by 102 open hearth furnaces in Allegheny County is one of the remaining important sources of air contaminants in the county. The steel industry has been working to find a solution to the collection of this effluent. The present method most adaptable to the open hearth operation, electrostatic precipitation, is regarded by some plants as too expensive."

Schreibeis also said that "with demands for energy produced by electric power, generating stations are expected to double within the next 15 years. Air pollution control officials must work to require the best collection devices on all new installations and make improvements on existing equipment which discharge air contaminants."

2 Typhoons Unify Sales Policies

Two Hupp Corp. divisions active in the air conditioning field, Typhoon Air Conditioning Co., and Typhoon Heat Pump Co., will now operate under uniform sales policies which will permit distributors and dealers of either line to handle the other under the same conditions.

"This means that Typhoon distributors and dealers will now have the broadest line available in both packaged air conditioners and in heat pumps," stated Don Petrone, vice president for sales of Hupp Corp., at a joint national sales conference for the two divisions.

U. S. Extends Air Pollution Program

The compromise bill which Congress passed last month authorizes a four-year extension of the air pollution control program at a Federal expenditure of $5 million a year. The House had voted a two-year extension of the act at $5 million, and the Senate advocated a four-year extension at $7,500,000.

Cleaner Air Week will be observed nationwide Oct. 25-31.

Pills Coated While Suspended In Air

The pill coating machine which coats pills "by air" has been patented by the Wisconsin Alumni Research Foundation. The device, which may replace the present pan coating method, was invented by Prof. Dale E. Wurster of the University of Wisconsin School of Pharmacy.

The machine suspends pills in air, forced into it by a blower, while atomizers inject a carefully controlled stream of coating material. The blast of air causes the coatings to dry immediately.

2nd Dirtiest City Asks U. S. Survey

Charleston, W. Va. wants to be the "guinea pig" for any study which the U.S. Public Health Service may make on air pollution from exhaust fumes.

The fact that Charleston has been labeled "the dirtiest city in the U.S." (up to the time Alaska became a state, the honor then going to Anchorage) apparently spurred the request.

Representative John Slack of W. Va. wrote Surgeon General Leroy E. Burney that Charleston would offer controlled conditions for such a study because of its restricted size and compactness.

He also pointed out that Charleston had received much adverse publicity from the report issued last year. The report said it had the most polluted air.

Editorial (Cont.)

Hospital Air Conditioning Registers Good Deed

(Continued from preceding page)

cient filters which trap dangerous airborne particles in hospitals scattered around the nation.

(Coming soon in AIR ENGINEERING *. . . a series of articles on hospital air sanitation and air conditioning . . . latest research results on staph infection control in various hospitals.)*

Hero is the air conditioning industry – its response to the challenge of maintaining health as well as comfort in hospitals (or wherever health-deserving people congregate) has been quick and encouraging.

Another point:

Air conditioning applications in hospitals *dramatize* what filtered, heat-and-humidity-tempered pure air can do to improve the health of those millions of human beings who spend much of their lives cramped together in big buildings.

If "applied" air conditioning can *save* lives in hospitals, it also can prevent inhabitants of factories, hotels, and office buildings from *needing* to go to hospitals.

Score another victory for this alive-and-vital branch of AIR ENGINEERING. ▲▲

States, Cities Act On Air Problems

Here's what the states, and major cities, are doing about air pollution control and air conditioning:

In New York City, a joint study underway by two city departments is seeking to find out if air pollution and abrupt climatological changes have any effect on illness and mortality rates in the city.

The survey by the Departments of Air Pollution and Health is scheduled for completion in June, 1960. It is being assisted by a $41,540 grant from the Federal Public Health Service.

Dr. Leonard Greenburg, Air Pollution Control Commissioner, said that the study might show a relationship between the frequency of homicides, suicides and accidental deaths in New York City and the climatic conditions that precede such fatal episodes.

In San Francisco, three major changes were made in the Bay Area Air Pollution Control District's new Regulation No. 2 (industrial, incineration, heat & power generation facilities). These are:

(1) the 45 lbs. per hour ceiling on dust and droplet emissions will be changed for larger operations. The degree has not yet been determined.

(2) the rule limiting future sulfur oxide emissions to .6 lbs. ppm (originally scheduled to take effect in one-and-one-half years, after further public hearings) will be dropped, if a suitable board policy can be developed, and with the stipulation that public hearings for additional possible regulation should be held within two years.

(3) the regulation will be changed to permit sulfur oxides emissions from stacks to exceed 2000 ppm, if adequate ground checking and monitoring services are provided by the source industry. Changing this rule will also allow specific rules regarding scavenger plants to be dropped.

In Lorain, Ohio organization of an Air Pollution Control Administration moved nearer completion as an APC control board, appointed earlier this year, held formal meetings. An APC officer is to be appointed. The city council earlier allocated funds for air pollution control activities.

Pollution Complaint$

Where there's a pollution problem there's a market for equipment to solve that problem . . . dust collectors, scrubbers, precipitators, blowers, other equipment.

Each month we plan to summarize air pollution situations in cities across the land as a service to equipment manufacturers.

We also plan to follow-up directly with each company involved to cover the solution to their problem as a service to our readers.

Newark, N. J. — Essex County Hospital, Cedar Grove, was cited for smoke from unburned fuel from heating plant and faulty incinerator emitting fly ash and soot. Hospital's chief engineer, James H. Jackson, was said to have recommended two electrostatic precipitators last November.

• • •

Buffalo, N. Y. — After three days of testimony, U. S. Rubber Reclaiming Co. was found guilty of violation of Cheektowaga air pollution ordinance.

• • •

Detroit—The case of Huron Portland Cement Co. vs City of Detroit is still pending before the U.S. Supreme Court. At issue is whether Detroit has jurisdiction over firm's ships on the U.S. side of the international boundary between this country and Canada, in the Detroit River. Older ships of the firm are said to emit considerable dense smoke. Spokesmen for the firm say it would cost upwards of $60,000 per ship to modernize coal burning equipment to meet city codes.

• • •

North Little Rock, Ark. — This city's asphalt plant is paving the way to air pollution complaints due to dust emissions, according to area voters. Four possibilities have been noted as solutions: 1. Spend some $12,000 on dust control machinery. 2. Move the plant. 3. Buy asphalt from somebody else. 4. Admittedly with tongue-in-cheek, City Finance Director O. R. Renfro suggests . . . "buy all those people out there an air conditioner and let them keep their windows closed."

Plant was originally built for $53,000, without dust control equipment. To install dust control equipment now would, according to plant officials, be prohibitively expensive.

Meetings, Courses, Expositions

Federation of Sewage & Industrial Wastes Association meeting, *Statler-Hilton hotel, Dallas, Oct. 12-15.*

American Public Health Association 87th annual meeting, *Convention Hall, Atlantic City, Oct. 19-23.*

National Society for Clean Air, Diamond Jubilee International Clean Air Conference and Exhibition, *London, England, Oct. 20-23.*

Oil Heat Institute of America, Inc., board of directors meeting, *The Homestead, Hot Springs, Va., Oct. 28-30.*

Association of Consulting Chemists and Chemical Engineers meeting, *Biltmore hotel, New York City, Oct. 28.*

Industrial Hygiene Foundation annual meeting, *Mellon Institute, Pittsburgh, Oct. 28-29.*

Air Conditioning and Refrigeration Institute, 11th Exposition of the Air Conditioning and Refrigeration Industry, *Public Auditorium, Atlantic City, Nov. 2-5.*

American Society for Metals, annual exposition and congress, *International Amphitheatre, Chicago, Nov. 2-6.*

U. S. Public Health Service training course in control of particulate emmissions, *Robert A. Taft Sanitary Engineering Center, Cincinnati, Nov. 2-13.*

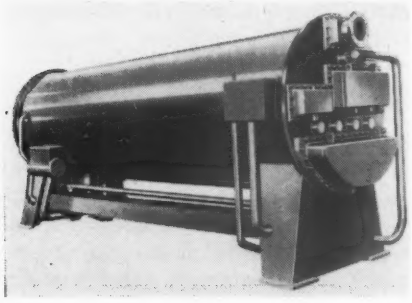
Institute of Boiler and Radiator Manufacturers semi-annual meeting, *Seaview Country Club, Absecon, N. J., Nov. 9-13.*

U. S. Public Health Service training course in control of gaseous emissions, *Robert A. Taft Sanitary Engineering Center, Cincinnati, Nov. 16-20.*

U. S. Public Health Service seminar on "Air Monitoring and Sampling Networks," *Robert A. Taft Sanitary Engineering Center, Cincinnati, Nov. 23-24.*

27th Exposition of Chemical Industries, *Coliseum, New York City, Nov. 30-Dec. 4.*

New PRODUCTS



Hermetic Absorption Cold Generator

Completely hermetic absorption Cold Generator is powered by low-pressure steam and uses water as the refrigerant with lithium bromide as the absorbent. It has capacities from 100 to 350 tons.

Single-shell design and hermetic pumps prevent air leakage to maintain full-rated capacity and resist oxidation. The hermetic design and simplified purge system make possible the purging of air from the machine only a few times a year.

Control system operates machine so as to avoid crystallization.

Source: *The Trane Co., Dept. AE, La Crosse, Wis.*

Roll-Gear Combinations

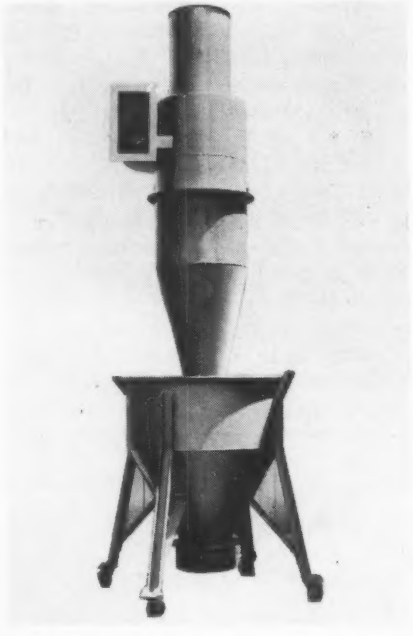
A one-piece combination of forming roll, drive gear, and shaft for small, power-driven machines is used in sets of 10 to 20 which progressively form locks, seams, cleats, and flanges in the ducts for heating and air conditioning systems and for many other purposes.

The roll-gear combinations are machined from solid cold finished steel bars 2 to 6 in. in diameter. Alignment is permanent because no taper pins or set screws, which may loosen or shift, hold rolls and gears on the shafts.

Source: *Lockformer Co., Dept. AE, 4605 W. Roosevelt Rd., Chicago 50.*

Involute-Type Dust Collector

A new and improved involute design of mechanical dust collector permits high efficiency collection of abrasive or heavy dust loadings such as may be found in steel sintering, petroleum refining,

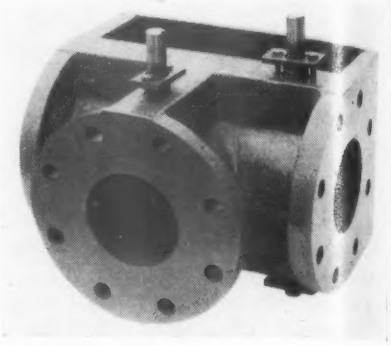


chemical and cement plants. Virtually any size job can be handled through the wide variety of arrangements made possible by the new Type IC collectors.

Catalyst dust suspended in reactor effluent and regenerator flue gases from the fluid catalytic cracking process may be efficiently collected by the new involute-type collectors.

To handle highly abrasive dusts, such as sintered iron ore, and blast-furnace dust, the new involute type collectors can be fitted with steel mesh liners incorporated with castable cements.

Source: *Research-Cottrell, Inc., Dept. AE, Bound Brook, N. J.*



2-In-One Valve

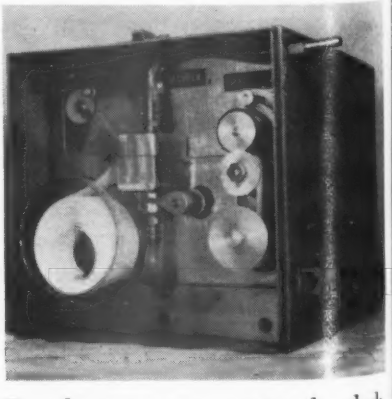
A new 2-in-one valve does the work of two conventional butterfly valves and a flanged "T" connection. It controls flow in cooling water systems and in other applications where two streams flow to or from a single pipe. Shaft packing may be removed from either end of the through shaft, inspected, replaced or adjusted without removing the valve. The triangle valve is a single unit – two butterfly valves in a flanged "T" body. Available in sizes 1 in. through 12 in.

Source: *U. S. Valve & Engineering Co., Dept. AE, P. O. Box 14015, Houston, Texas.*

Portable Air Sampler

Portable paper tape air sampler for recording dust or gas concentrations will automatically collect up to 900 dust or gas samples by sucking air through a paper tape.

The volume of air per sample is adjustable from 1.5 to 36 cu. ft.



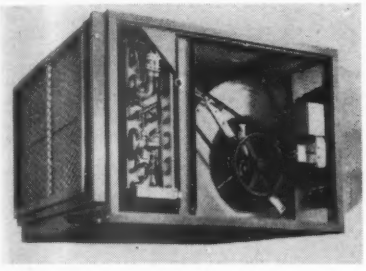
For dust measurements, the darkening of the ½ in. dia. sampling spot is measured with a densitometer. If radioactive dusts are in-

volved, the tape can be passed under a Geiger counter.

For gas measurements, there are available specially treated papers that change color in the presence of many gases, such as hydrogen sulfide, carbon monoxide, hydrogen cyanide, and phosgene.

Sampler is compact and portable. With its steel case it weighs 21 lbs. A new volumetric piston vacuum pump with graphite rings that require no lubrication is used.

Source: *Gelman Instrument Co., Dept. AE, Chelsea, Mich.*



Does Spot Cooling Job

Dual-purpose air handling unit for spot cooling employs large fans with low tip speed for maximum air velocity at low noise level.

Series HB are available in 2, 3, 4, and 5-ton sizes. Largest features twin blower wheels.

Units are suitable for free suspension in area to be cooled with the addition of a double deflection discharge head and filter screen.

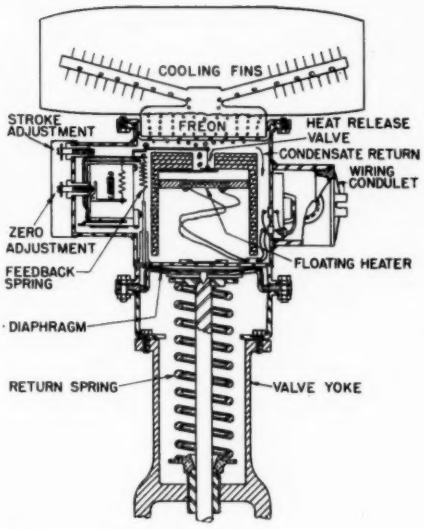
Source: *Fraser-Johnston Co., Dept. AE, 1900 17th St., San Francisco 3.*

Noncorrosive Spray Nozzles

Hollow cone spray nozzles, injection molded of Tenite Butyrate, provide noncorrosive spray heads for air washers, cooling towers, spray ponds, evaporative condensers, etc.

Because of the design and the low inherent friction of the material, spraying begins at ½ psi. The nonporous material resists build-up of lime and other deposits.

Source: *Austin Mfg. Corp., Dept. AE, 305 Perry Brooks Building, Austin 1, Texas.*



Thermo-Drive Actuator

Improved model of the vapor-powered Thermo-Drive actuator for electronic control systems permits stroke and zero adjustments, and provides full operating thrust with lower internal pressures.

It has only two moving parts. An electrical resistance strip heater vaporizes a liquid at a continuous rate. The pressure of the vapor drives a diaphragm against the valve actuating stem.

Primary difference between the new Thermo-Drive and the earlier model is a more efficient vapor-producing liquid which has a high boiling temperature at a pressure less than 40 psi.

Source: *The Swartwout Co., Inc., Dept. AE, 18511 Euclid Ave., Cleveland, Ohio.*

Continuous Line Diffusing Grille

New continuous line diffusing grille, Model STWA, is designed to maintain the functional straight-line beauty of modern architecture. It can be mounted in ceiling, floor, sill or side wall. When installed in continuous runs, individual sections butt neatly together without noticeable breaks.

The new grille incorporates an adjustable core which permits adjustment of the air pattern through a simple setting of the fins. It is normally furnished with a 5° deflected vertical air pattern which can be altered up or down by inverting the grille. It can also be supplied with a 15° vertical deflection for special applications.

Source: *Barber-Colman Co., Dept. AE, Rockford, Ill.*

Use Communications Center, page 35, for requesting more information about articles, advertised products, literature, etc.

All-Filter Dust Mask

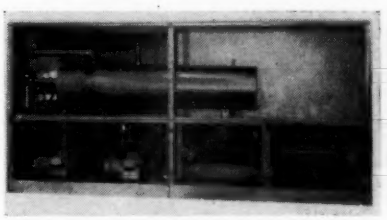
Entire mask is filtering area in new, lightweight, urethane filter respirator called Resp-R-Aid. Mask is molded in one piece of plastic foam.

Increased filtering area greatly

reduces inhalation resistance to make breathing considerably easier. Special urethane construction filters out even minute particles.

Urethane filter can be washed repeatedly and reused.

Source: *Watchemoket Optical Co., Inc., Dept. AE, 232 West Exchange St., Providence 3, R. I.*



Self-Contained Chiller

Type SCC "Chillpak" is complete self-contained water chiller with all components including evaporative condenser in one cabinet. It is available in 12 basic models from 15 to 120 tons' capacity.

Source: *Governair Corp., Dept. AE, 4840 N. Sewell, Oklahoma City.*

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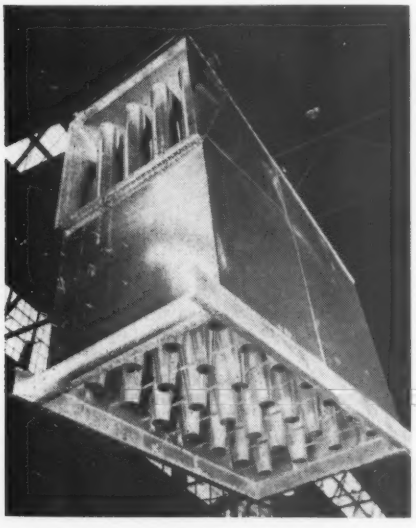
New PRODUCTS

(Continued from preceding page)



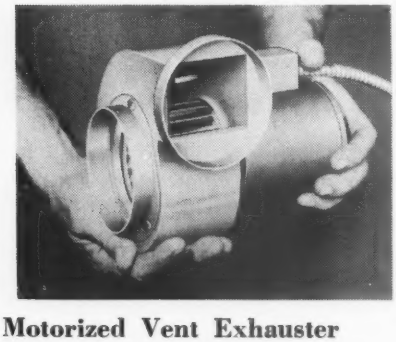
Dust Collector for Cement Kilns

Vertical tube mechanical dust collector, especially designed to be free from plugging for use in cement plant applications, is now available.

Designated the American Blower Series 345 dust collector, the new unit contains 15-in. vertical steel inlet tubes with engineered tapered outlet to eliminate reintrainment and reduce plugging. The collector is recommended for any application where tube plugging in smaller tube collectors is normally a problem.

Collection efficiency is compatible with normal primary collector requirements where a secondary electrostatic precipitator or silicone glass bag is to be utilized.

Source: *American-Standard Industrial Div., Dept. AE, Detroit 32.*

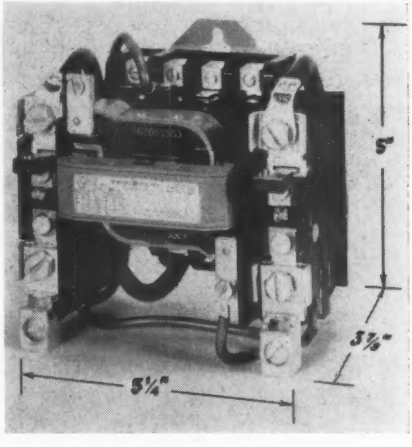


Motorized Vent Exhauster

A new motorized vent exhauster vents exhaust gases from unit heaters directly to outdoors through sidewall of the building. It requires only a short length of standard, lightweight 4-in. pipe.

Model V300 is used with heaters from 25,000 to 300,000 Btu input. An adapter is used for attaching venter to the flue. Adapters have built-in restrictors to control volume of gases drawn through exchanger and to provide more efficient combustion.

Source: *Reznor Mfg. Co., Dept. AE, Mercer, Pa.*



Air Conditioning Starter

Two new contactors and starters for control of air conditioning compressor motors from 7½ through 20 hp. are rated at 50 and 60 amperes, 110/220 volts, or at 25 and 30 amperes, 440/550 volts.

They can be furnished with two or three poles, and either can be ordered with one auxiliary contact. Starters can be obtained with quick-trip overload relays for protection of hermetically sealed motors.

Source: *General Electric Co., Dept. AE, Schenectady 5, N. Y.*

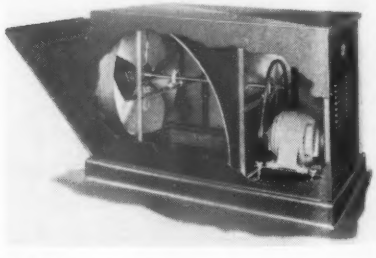
Felt Insulations

A complete line of spun mineral wool felt insulations designed for use in high temperature industrial equipment, heated appliances, and refrigeration systems is available in densities ranging from 3 to 8 lb. per cu. ft. and with a variety of surface facings.

Some suggested high temperature applications of B-E-H Spun Felts are ovens, dryers, stoves, and ducts. In addition, the material is designed for use on refrigerated surfaces of freezers and air conditioning systems.

Made from spun mineral fibers with a phenolic resin binder, B-E-H Spun Felts can be used to insulate surfaces having temperatures from below zero to 450 F.

Source: *Baldwin-Ehret-Hill, Inc., Dept. AE, 500 Breunig Ave., Trenton 2, N. J.*



L-Blow Exhauster

L-Blow exhauster, new packaged roof ventilator, exhausts air against medium static resistance. It is available in wide range of sizes in two series.

Series LBA have spark-proof aluminum alloy high-speed propeller and isolated motor drive for use in industrial processing and drying systems.

Series LBS have wide-blade slow speed steel propellers for quietly exhausting air against low resistance.

Source: *Romla Co., Dept. AE, 13101 S. Main St., Los Angeles 61.*

New Literature

Helps Solve Make-up Air Problems

Bulletin EN-5911 describes how make-up air properly introduced and tempered will overcome negative air pressure and its problems.

The illustrated four-page bulletin outlines the design of a make-up air system and how to select the correct equipment for such systems. Also included are a schematic diagram and instructions for properly wiring the control arrangement for make-up air installations.

Source: *Reznor Mfg. Co., Dept. AE, Mercer, Pa.*

Air Pollution Bibliography

A second volume of "The Air Pollution Bibliography," covering material published between 1952 and 1958 has been compiled for the Public Health Service, U. S. Dept. of Health, Education, and Welfare. Copies are free.

Source: *Air Pollution Engineering Program, Div. of Sanitary Engineering Services, U. S. Public Health Service, Dept. AE, Washing 25, D. C.*

Use Communications Center, page 35, for requesting more information about articles, advertised products, literature, etc.

Elimination of Nitrogen Oxides

"Elimination of Oxides of Nitrogen from Automobile Exhaust" presents results of a search for a catalyst capable of inducing reduction of nitrogen oxide. An efficient catalyst, incorporated into a suitably designed muffler, would constitute a major step in eliminating smog.

Investigation was conducted by The Franklin Institute and the report written by Francis R. Taylor.

Investigators found, among other things, that zinc-copper chromite, iron chromite, barium promoted copper chromite, and chromium promoted iron oxides are very efficient for removing nitrogen oxides in the presence of CO or, in some cases, in presence of H_2 at temperatures of approximately 220 C and 320 C.

Report is No. 28 issued by Air Pollution Foundation. Price $2.

Source: *Air Pollution Foundation, Dept. AE, 2556 Mission St., San Marino, Calif.*

Redmond Distributors Catalog

New 12-page 2-color catalog shows fractional horsepower electric motors, blowers, replacement kits, fan blades, and accessories available through Redmond distributors.

Source: *Redmond Distributors Div., 201 Monroe St., Owosso, Mich.*

Range Hood Ventilator

Catalog 1201 gives detailed description of the Morrison Filtaire line of packaged range hood ventilators for kitchens in mass feeding establishments.

Filtaire is a self-contained unit complete with grease filters, blower, motor drive and cabinet. Contents of the booklet include specifications and dimensions for basic models and special units for high static application, and procedure for engineering installation, including how to determine hood design, required air delivery, friction losses due to exhaust duct and how to select the correct size Filtaire.

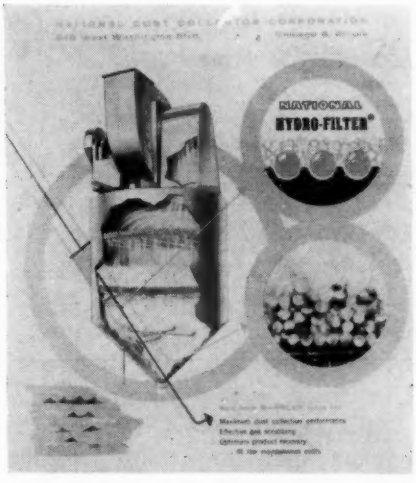
Source: *Morrison Products Inc., Dept. AE, 16816 Waterloo Road, Cleveland 10.*

Industrial Fan Data

Fundamental data relating to capacities and construction of Lehigh Type I.E. line of industrial fans are presented in a 28-page bulletin in color.

Bulletin L-5 contains rating tables, correction ratios for deviations from standard atmospheric conditions, definition and illustration of fan laws, and dimensions.

Source: *Lehigh Fan & Blower Div., Fuller Co., Dept. AE, Catasauqua, Pa.*



Hydro-Filter Bulletin

A six-page bulletin illustrates and describes the operating principle of the National Hydro-Filter, a wet-type dust collector used for the collection of dust fumes.

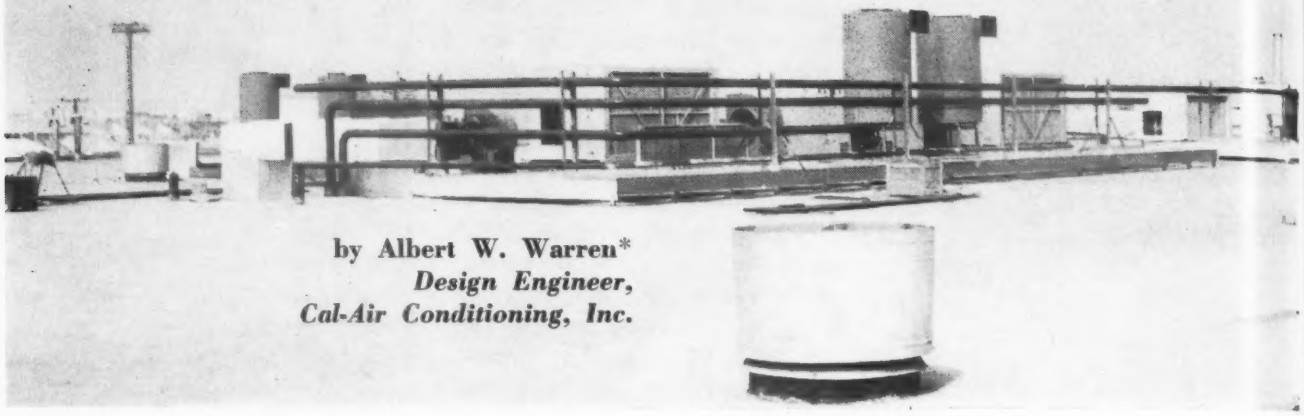
Included are dimensions, specifications and capacity data on four models, ranging in capacity from 1,000 to 40,000 cfm.

The National Hydro-Filter employs ordinary playing marbles in the separation action.

Source: *National Dust Collector Corp., Dept. AE, 700 Machinery Hall, Chicago 6.*

For Tomorrow's Airplane Bodies and Wings . . .

Air Conditioning Helps Make Stainless Steel "Sandwich"



by Albert W. Warren*
Design Engineer,
Cal-Air Conditioning, Inc.

Fig. 1: *Air conditioning and cleaning equipment installed on North American Aviation Co. plant roof is mounted on platform completely floated above roof area and tied to structural roof members by steel overclamps spanned at 15 ft. intervals. Photo courtesy of Drayer-Hanson.*

Stainless steel brazing requires ultra-clean surfaces of formed metal. Metal cleaning rooms demand rigid control of air temperature, humidity, cleanliness, and fume removal.

BEFORE STAINLESS STEEL SHEETS and cores can be brazed into a honeycomb sandwich to withstand high pressures and temperatures when used in high-speed airplane bodies, wings, etc., they must be thoroughly cleaned of any foreign matter, including oil from handling, under rigid temperature and humidity conditions.

For such cleaning, North American Aviation, Inc. has set up a three-room area measuring 60 by 210 by 24 ft. that is actually an insulated air conditioned, vapor-sealed building within a building at its El Segundo, Calif. plant.

Cleans Ton of Metal In 15 Minutes

The three air conditioned rooms in the area are a large metal cleaning room where three and five-ton cranes lift stainless steel baskets of parts measuring up to 12 by 6 ft. and dip them into huge processing tanks, a lay-up room where parts to be processed are assembled, and an air-lock that acts as a vestibule between the outer plant and the lay-up room.

The metal cleaning room was designed to handle approximately 2,000 lbs. of metal every 15 minutes or approximately 8,000 lbs. of metal per hour.

The stainless steel parts, in various shapes and forms, are about .003 in. thick. The cores vary from ¼ to 4 in. thick. The cleaning process varies, depending on results desired.

One process consists of the stainless rack and its parts being placed first in a degreasing tank, then in a nitric acid tank approximately 40 percent nitric. From there it goes to a water rinse tank, to a hot alkaline tank, back through the water rinse, then to the drying oven. There it is left for about 15 minutes with the metal heating up to about 200 F.

Metal is then removed and left on the racks to cool back down to room temperature before being removed to the lay-up room.

Air Must Be Dust Free

Air in the three-room area must be kept dust-free and held at constant temperature and humidity. That in the metal cleaning room must in addition be kept free of nitric acid and trichlorethylene fumes and hot alkaline vapors.

Cal-Air Conditioning Co. designed and installed the process heating, ventilating, and air conditioning system for this area. The system is a pilot model which will be duplicated in a much larger system.

North American specified that temperature in the facility be maintained at 75 F with 40 to 50 percent relative humidity, and dust control to no more than four to six microns.

In talking to North American plant engineers about the problem of metal cleaning of stainless steel

**20 Years' experience in the air conditioning field with six years in design for industrial problems covering such areas as steam plants, dust collections, smog control, and electronic heat load control.*

for brazing, it was found necessary to have the following information:

1. Desired schedule of metal cleaning.
2. Weights of metal to be handled per hour.
3. Temperatures and humidities desired for each area.
4. Locations available for remote equipment such as boiler, compressor, and cooling towers.
5. Flow diagrams satisfactory to customer operation.
6. Coordination of other trades that were involved in the design and construction of this facility.

Problems involved in each area in addition to specified temperature, humidity and dust control were:

A – Metal Cleaning Room

The cleaning tanks and their exhaust. These were the degreaser, 14 ft. deep, 15 ft. long, and 12 ft. wide, including generation system and transfer tank; a large (8 by 14 by 7½ ft.) and a small (3 by 14 by 7½ ft.) nitric acid tank, two 8 by 14 by 7½ ft. hot alkaline tanks, a 72 kw. electric drying oven, and the degreaser pit exhaust.

Miscellaneous items such as light load, people load, metals handling. People were considered only to the extent that they be kept cool enough to prevent perspiring and to keep any moisture from their hands from depositing on stainless steel.

B – Lay-Up Room

In this room we had the problem of materials being delivered into and out of the room, light loads of 65 ft. candles, and internal equipment load.

C – Air Lock Room

Traffic from non air conditioned area could not be permitted to contaminate the air or affect the temperature and humidity of the lay-up room to any degree.

In the metal cleaning room, exhaust from the tanks was of prime importance due to contamination of the air by the nitric acid fumes and the trichlorethylene fumes of the degreaser tank and the moisture deposited in the air from the surface of the hot alkaline tanks.

Nitric Fumes Scrubbed

The Air Pollution Control District requires nitric acid fumes to go through a scrubbing process before being dumped to the atmosphere. For the scrubbing process, air is introduced into a collecting type cylinder down through the top and forced down across two banks of spray nozzles and picked up by the scrubber blower, forced through water eliminators, and spiralled up the outer surface of the scrubber to the atmosphere.

Also the water used in scrubbing the nitric acid fumes must be dumped in a proper manner through proper piping to a neutralizer pit.

The total exhaust of air for the metal cleaning room totalled approximately 59,300 cfm. This determined the total make-up capacity, with humidity and temperature control creating a cooling load of approximately 185 tons of refrigeration.

The push-pull method of exhausting air from the nitric acid and the hot alkaline tanks was taken from

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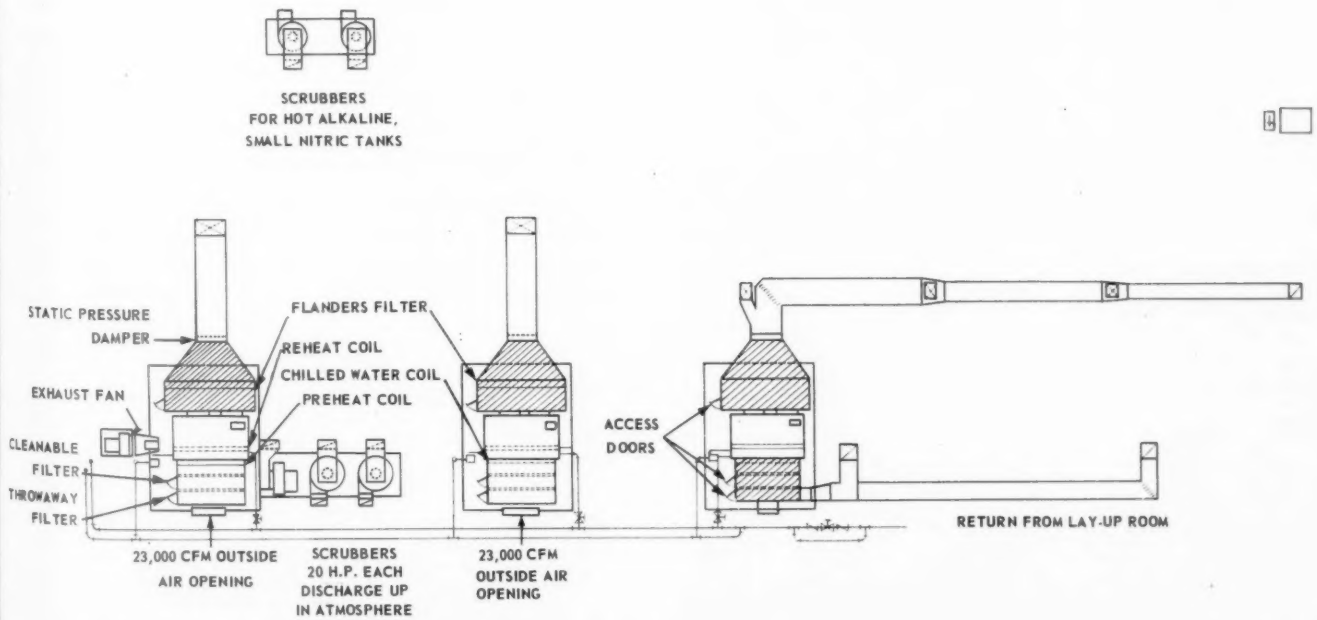


Fig. 2: *Layout of equipment shown in Fig. 1 with major components of air handling system identified.*

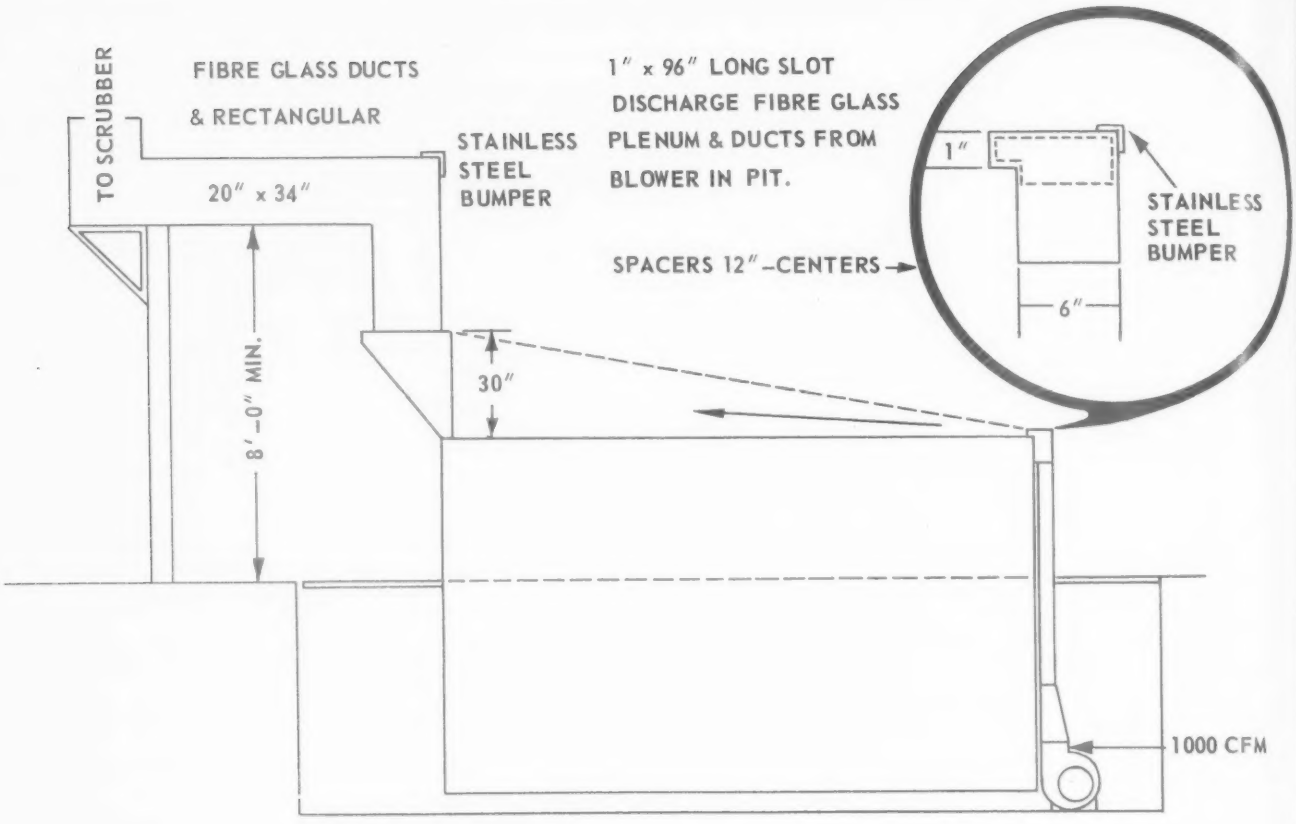


Fig. 3: *Drawing shows how the push-pull method of exhausting air from the nitric acid and hot alkaline tanks works.*

(Continued from preceding page)

a study made by the automobile manufacturers of Detroit[1]. Volume of air exhausted from the surface of the tank is determined by the area of the tank. Height of hood opening is determined by the length of the tank. (See Fig. 3.)

In other words, a line drawn from the furthest edge of the tank at an 11 or 12 degree angle to the top of the hood determines the height of the hood. On these 14 ft. long tanks the height of each hood was 30 in.

Supply air was introduced at the far end of the tank and blown at a velocity of 1500 to 2500 fpm at a slight angle down and across the material or liquid in the tank. The liquid is held to approximately 6 in. below the top edge of the tank. A three-sided duct partially controls the supply of air across the tank and starts the materials we were trying to exhaust in the proper direction. The hood at the other end thus picks up such a large volume of air (about 200 cfm per sq. ft. of tank surface) that it is able to capture all of the moisture or fumes that would have otherwise been deposited in the room.

Small (1000 cfm) blowers that furnish the supply air to far end of each tank are located in the pit at the base of the tank being ventilated. They are also used to ventilate or exhaust the pits. Thus air drawn from the pit was introduced as supply air across the tank and was exhausted through the exhaust system so that no contamination of air in the room was possible.

In considering the heat load from the tanks, such as the hot alkaline tanks and the ovens, it was necessary to make detailed calculations as to the amount of radiation that would be given off from the tanks as well as figuring the actual Btu load required to heat the hot alkaline up to a required temperature of 190 to 210 F.

Air Distribution Cycle

Three roof-mounted air conditioning units supply a total of 71,000 cfm of fresh air to the conditioned area (Figs. 1 and 2). Only the unit serving the lay-up room uses return air. Approximately 60 percent is recirculated.

Fresh air first passes through a set of throw-away filters and then a bank of cleanable filters.

Then it moves over a pre-heat coil where its temperature is raised, if necessary, to 70 to 80 F. A chilled water coil drops it to 54 F and a reheat coil brings it up to the desired 75 F. This properly tempers, cools, and dehumidifies the air.

Steam for the heating coils is supplied at 15 psi by a 225 hp. boiler.

On the discharge side of the air handling units, absolute filters remove air contaminants above three

microns in diameter. Then the air passes through static pressure dampers set to determine the static pressure within the areas served. It goes down through the roof into ducts above the ceiling of the metal cleaning room, the lay-up room, and the office area just outside.

Air is then distributed to the various rooms through diffusers with adjustable cores that may be adjusted from one to four ways of diffusing, depending upon the size of diffuser and number of cores in each diffuser.

Core sizes very from 3-in. squares through 8-in. squares. For example, a 12 by 12-in. diffuser would have nine 4-in. cores or four 6-in. cores. These may be directed in any one of four directions.

The metal cleaning room is finished off with ½-in. dry-wall and taped and painted an enamel to help maintain a dust-free atmosphere.

Had To Clear Crane Ways

All ductwork and exhaust hoods had to clear the crane ways. Any ductwork offsets or shelves where dust might accumulate are kept at a low level so daily vacuuming is simplified. Diffusers in the ceiling keep any dust from accumulating on top of the crane ways.

Pneumatic temperature control system for the lay-up and metal cleaning rooms automatically maintains ⅛-in. static pressure in the rooms.

Actual control of temperature and humidity for each of the air conditioned units on the roof is accomplished through sub-panels recessed into the wall of the rooms they serve.

A monitoring master panel is located in an electric control room next to the metal cleaning room. On the panel are indicating dials that show outside temperature (both wet and dry bulb), room temperatures, and wet bulb and static pressure of each room.

All magnetic starters and disconnect switches are also located in this room.

In the air-lock room, a 3000 cfm air handling unit positioned on a 2 by 8-ft. platform over the ceiling delivers 100 percent fresh air at ceiling line. Room air is exhausted through 8-in. by 12-ft. slots in the floor at each large door opening.

This creates a curtain of air at the door and maintains approximately ⅛-in. water gauge pressure within the room when the doors are closed.

Super grates in the floor prohibit anyone from falling into the opening. They are of sufficient strength to support the weight of light trucks that pass over the grating.

Air is drawn down into a concrete trench. It is carried to the exterior of the room and then up the wall through a metal duct to the exhaust system that also removes air from the lay-up room and finally out through the roof into the atmosphere. ▲▲

CREDITS

Designer-Installer: *Cal-Air Conditioning, Inc.*

General Contractor: *Aldous Construction Co.*

Plumbing, Mechanical Contractor: *R. E. Thrane Co.*

EQUIPMENT INSTALLED

Air Handling Units: *Drayer-Hanson*
Fans & Scrubbers: *Master Fan Co.*

Compressor: *Trane Co.*

Cooling Towers: *Recold Corp.*

Pneumatic Temperature Controls: *Johnson Service Co.*

Absolute Filter: *Flanders Filters, Inc.*

Throwaway and Cleanable Filters: *Farr Co.*

Boiler: *York-Shipley, Inc.*

Diffusers: *Controlair Co.*

BIBLIOGRAPHY

1. Hama, George M. "Supply and Exhaust Ventilation for Metal Pickling Operations," *Air Conditioning, Heating and Ventilating* 54: 61-63. Sept., 1957.

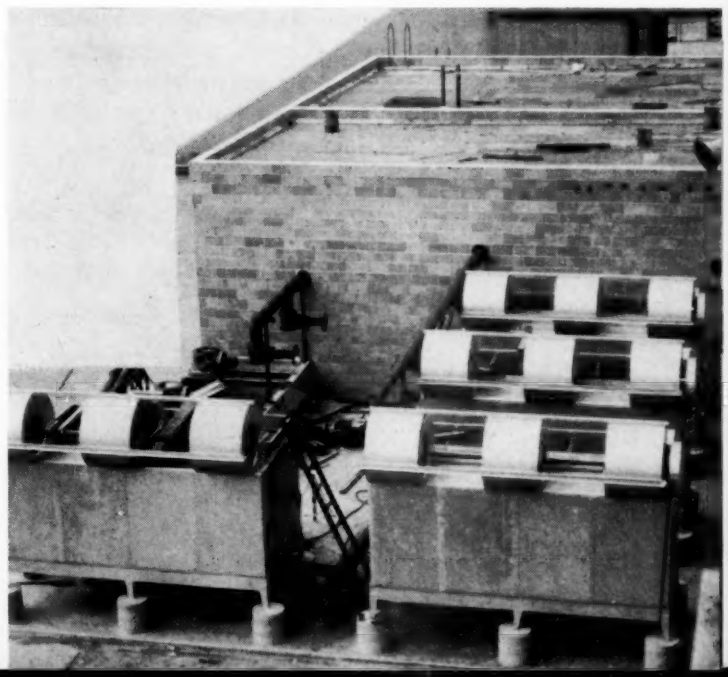


Fig. 4: *Three of system's four cooling towers handle the load with the fourth left idle for proper maintenance. All water is drained through 10-in. pipe into concrete reservoir from where one of two 75-hp. motors distributes it through condensing system. An additional 4-in. line was extended through main building and capped off over metal cleaning room to furnish additional condensing water as needed at 100 psi. Photo courtesy of Drayer-Hanson.*

For your air cleaning problems . . .

How to Design Dust Control Systems

by W. O. Vedder
Vice President,
Pangborn Corporation

Here are tips on duct system design, hood selection, centrifugal, wet, precipitator and cloth bag filters, and blower units.

DUST CONTROL IS NO LONGER just a nice thing to have around provided it doesn't get too expensive: today it is recognized as an absolute necessity in some cases, a practical method of boosting production and cutting costs in most others.

Most dust control equipment is purchased because of industry's honest desire to provide good working conditions for its people – or being forced to clean up the atmosphere by ever-tightening air pollution laws – or because it finally dawned on some wideawake manager that a few handfuls of valuable dust lost each hour adds up to a substantial and costly material loss over the year.

After the dust control system is installed and operating, most companies discover four bonus benefits: proper dust control permits recirculation of cleaned air, prevents exhausted dust from re-entering work areas, improves plant housekeeping and decreases building maintenance, and cuts wear and maintenance on operating equipment.

Following discussion of exhaust methods and equipment presents the major factors to be considered when planning a dust control system.

Dust control systems consist of (1) the exhaust hoods and piping system, (2) dust collecting equipment, and (3) the exhauster and its drive. Each component must be considered separately in relation to the type and amount of dust to be handled.

Exhaust Hoods

Exhaust hoods to a large extent govern the effectiveness of dust control. Therefore, dust producing operations and processes should be as completely enclosed as possible. Next to complete metal enclosure, canvas or rubber drop curtains are recommended.

Fig. 1: *Properly designed exhaust hoods and piping system trap toxic lead dust particles as fine as 8 to 10 microns at Electric Storage Battery Co., Philadelphia.*

When complete or semi-enclosure of the process is impossible, the exhaust hood should be located as close to the point of dust production as possible. Hood design varies to fit the type of process covered.

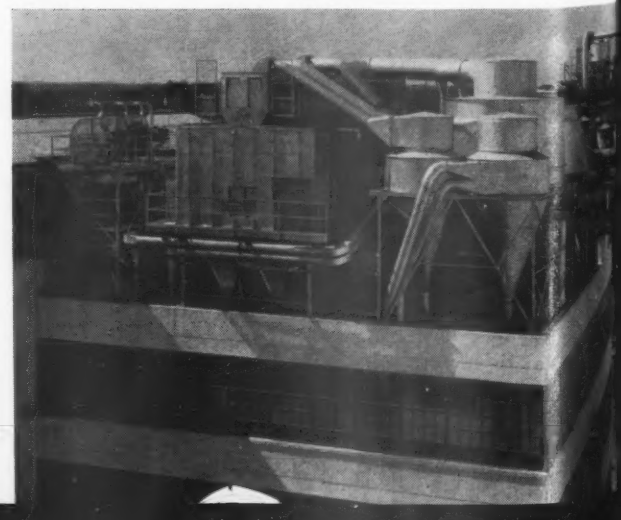
Fig. 1 illustrates typical hood designs. Hoods, along with flanges, baffles, skirts, vanes, etc., should direct maximum flow from the dust producing area with minimum flow from surrounding areas where no dust is generated.

Piping

Diameter of piping used to connect exhaust hoods to dust collecting equipment depends upon the volume of air to be removed and the velocity at which it should be withdrawn. In many localities codes specify connection sizes and air volumes for various operations (Table I) and in other instances pipe sizes are determined by calculation and experience.

When calculating for the cross-sectional area of any pipe, the air volume (cfm) to be removed (as

Fig. 2: *Centrifugal and cloth screen collectors at Kellogg Co. recover an average of 35 tons of grain dust per day. Salvaged material is worth $40 a ton.*



determined by codes, experience, or experiment) is divided by the velocity (fpm) recommended (Tables II and III) to remove the type of dust in question. Cfm capacities of branch lines are totaled to give cfm in main lines.

We suggest eight general specifications for average duty industrial exhaust system piping:

1) *Keep bottom of pipe straight* throughout its entire length – to avoid dirt-collecting pockets. Make changes in area with gradual taper top and sides only.

2) *Make branch connections only into side or top of tapered section of main-pipe.* A 30° angle is preferred; in no case should it exceed 45°. Branch connections should enter near large end of a tapered section.

3) *Lap joints in direction of air flow.* Keep piping free of obstructions.

4) *Support piping throughout its length by strap iron, angle or rod hangers.*

5) *Provide cleanout openings in lower side of pipe at regular intervals* and adjacent to bends, junctions, vertical risers, etc. Provide end cleanouts with removable caps.

6) *Elbows and bends should be formed with smooth curves* having a center line radius equal to 2½ times the pipe diameter and be constructed two gauges heavier than straight pipes of corresponding diameter.

7) *Locate blast gates for system resistance adjustment* in branches close to their junction with main pipe and provide means for locking in adjustment.

8) *Construct piping of galvanized steel* with riveted and soldered or lock seam joints: or black steel with welded joints, in the following gauges:

4 to 12 in. diameter – No. 20 gauge.
12 to 32 in. diameter – No. 18 gauge.
32 in. diam. and over – No. 16 gauge.

The Dust Collector

There are a number of types of industrial dust collectors in use. The most prominent are:

1) *Centrifugal Type Collector.* Centrifugal type collectors (Fig. 2) utilize radial acceleration of an air or gas stream to separate solid particles suspended and conveyed therein. The common large diameter cyclone is widely used, but is effective principally on coarser particles such as found in primary crushing operations or such applications as removal of shavings from woodworking operations. For control of smaller particles a higher efficiency type collector must be used.

Of more recent design are the small diameter high speed and multiple cyclone collectors which accomplish a higher degree of separation through development of higher centrifugal forces, but with resultant increase in resistance.

2) *Wet Type Collector.* In wet type collectors (Fig. 3) the dust particles are entrapped in a liquid, usually water, and conveyed by the liquid to a settling tank or disposal area. There are several types of wet collectors: water curtain, dynamic precipitator, impingement, centrifugal and combinations of these types. Wet type collectors are well adapted to higher temperature problems or applications involving high moisture content.

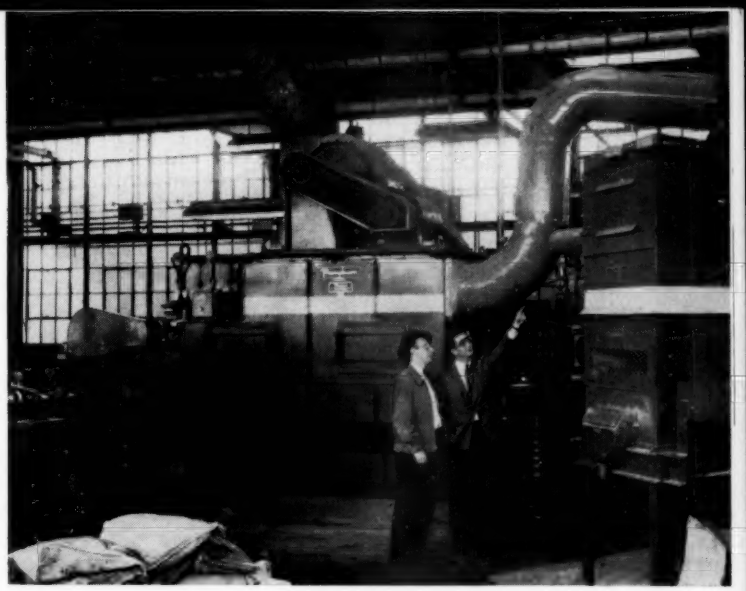


Fig. 3: *Venturi-type wet dust collector controls explosive, combustible magnesium dust at Wyman-Gordon Co., Worcester, Mass. Dust results from blast cleaning of magnesium aircraft forgings.*

3) *Electrical Precipitator.* Electrical precipitation is the process of removing suspended particles by the aid of an electrical field between electrodes in the air or gas stream. In the usual form of precipitator the negative electrode is of comparatively smaller diameter and placed close to the positive electrode which is of larger dimensions. The negatively charged particles are attracted to the posi-

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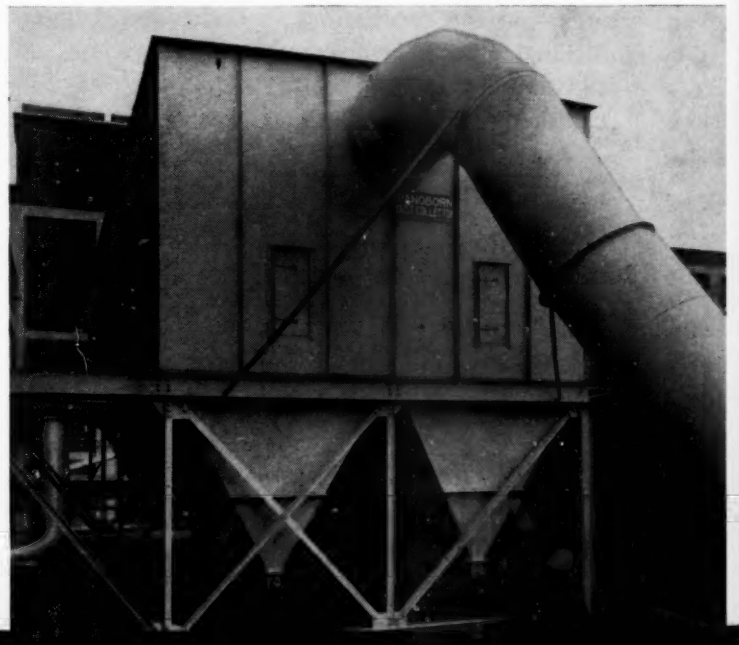
Fig. 4: *Cloth bag type dust collector serves dust sources at plant shown in Fig. 1.*



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tively charged electrode and collect on its surface. From here they either drop by gravity into hoppers below, or by interrupting the current and rapping the plate periodically, the precipitated material is dislodged and falls.

Electrical precipitation has been used for many years to recover particles from the flue gases in smelters, sulphuric acid plants, cement kilns, plants for detarring gases, etc. Large central power stations using pulverized fuels, use the process to remove fly ash and other solid impurities of finely divided nature. The over-all recovering efficiency of properly designed and applied electrical precipitation equipment is high on all particle sizes. However, due to its high initial and maintenance costs, its use has been chiefly confined to higher temperature problems.

4) *Cloth Type Filter.* This type of collector filters dust from the conveying air by flowing the air through specially designed filter fabric. Many variations in design are available. The cloth type filter is in general use for problems involving the collection of finely divided dry dusts. A continuous high recovery is possible at economical cost.

How It Works

A cloth filter collector consists of an air and weather tight casing enclosing the filter fabric, arranged so that all incoming air must pass through the fabric to the collector outlet. When dust laden air enters the collector a reduction in velocity occurs; this drops the coarser particles of material from the air stream.

The remaining dust is conveyed to the cloth surfaces where it is filtered from the air. The clean air then continues on to the collector outlet. The dust pack or mat formed on the cloth surfaces materially assists in improving recovery efficiency.

There are two general designs of cloth filters available, the tube or bag type (Fig. 4) and the cloth-screen type, (Fig. 5). They are similar in operation but the applications of each depend on the individual process involved, dust types, volume, etc.

In the cloth tube or bag type the filter takes the

TABLE I—Typical Pipe Size and Air Volume Code Specifications for Grinding Wheel Exhaust Systems

Wheel Dimensions Diameter (in.)	Maximum Width (in.)	Pipe Diameter (in.)	Air Volume* (cfm)
Up to 9	1½	3	220
Over 9 to 16	2	4	390
Over 16 to 19	3	4½	500
Over 19 to 24	4	5	610
Over 24 to 30	5	6	880
Over 30 to 36	6	7	1200

*At 4500 fpm 2.5 in. w.g. initial suction with .71 orifice coefficient.

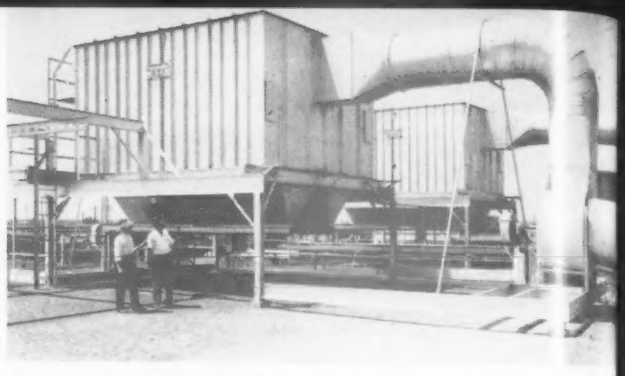

Fig. 5: *Self-cleaning cloth screen type dust collector control carbon black dust at Memphis plant of Firestone Tire & Rubber Co.*

form of a series of tubes or bags, open at one end and closed at the other, vertically suspended in the casing with the bottom or open end tightly sealed to thimbles in a plate. The dust laden air enters the casing below the seal or thimble plate and passes upward.

The dust is precipitated on the inner surface of the tubes or bags. They are attached to a shaking device, usually connected at the top, which is periodically operated to remove the dust pack from the inner surfaces of the fabric from which it drops to hoppers forming a part of the collector casing.

The cloth-screen type collector is a refinement of the tube or bag type. In this type the filter fabric is applied over a series of rectangular frames which effectively support the cloth. The fabric covers both sides and three edges of the frame with the fourth edge left open, forming a flue for clean air.

The open ends of the screens are sealed to each other or to the collector casing to divide it into a dirty (dust) side and a clean (clean air) side. The screen frames are connected to a shaking or rapping device for dislodging the dust pack from the cloth surfaces. Hoppers are provided below the screens into which the collector dust is deposited.

Intermittent and Self-Cleaning Types

As the build-up of the dust mat on the cloth surfaces results in a gradual increase in collector resistance, it is periodically necessary to stop the air flow and vibrate the cloth surfaces. With the more common collector arrangement, the intermittent type, the cloth is cleaned by periodic operation of the shaking device with the exhauster shut down. A cleaning period of five to ten minutes after each four to five hours operation is an average schedule.

The continuous self-cleaning type cloth collector is used for process applications where shut down periods cannot be permitted. Today, with round-the-clock and 3-shift production on every hand, continuous equipment is more in demand.

The self-cleaning collector uses the principle of reverse air flow for continuous cleaning of the cloth filters. This is accomplished by action of a traveling

manifold which includes an integral reverse air blower that takes its air directly from the clear air side of the collector. This manifold covers three vertical rows of cloth covered screen frames.

Manifold face is covered with a flexible diaphragm, having at the vertical centerline a row of orifice openings. The diaphragm is inflated against the grid wall under blower pressure. This reverse air is blown through the center row of screens while the manifold blocks normal air flow through the vertical rows on either side.

This arrangement blows the dust from the center row screens and allows it to drop to the hopper instead of being re-entrained, and at the same time prevents air short-circuiting. The blower motor in the traveling manifold is interlocked with the main exhauster motor to insure simultaneous operation.

Cloth Filter Limitations

Properly applied and maintained cloth filters will provide effective suppression of fine divided, as well as coarse, industrial dusts, but there are several factors that must be considered in applying them. Temperature, moisture and chemical qualities of both dust and conveying air or gas are most important.

The limiting temperatures for the filter fabrics in most general use are approximately 175 F for cotton and about 225 F for wool. Some of the newer synthetic fiber fabrics permit a considerable increase in practical operating temperature ranges. Improved chemical resistance is also possible through use of new fabrics.

When it contains moisture the conveying air and collector temperature must be maintained above the dewpoint to prevent condensation within the collector resulting in sludging dust on cloth surfaces.

The size of a cloth filter – that is, the filtering area – is governed by the air volume handled; the nature, characteristics and amount of material to be

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TABLE III—Velocity Contours and Direction of Air Flow for Circular Plain Openings Without Obstructions. (Curves of this type permit determination of air velocities at any point in front of exhaust hood as charted.)

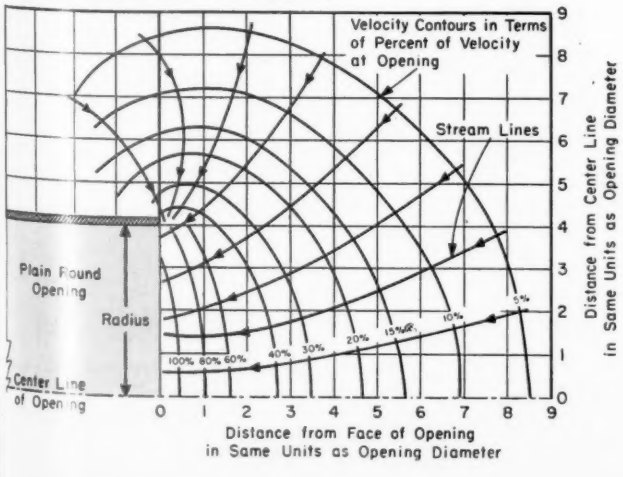
Velocity Contours in Terms of Percent of Velocity at Opening
Stream Lines
Plain Round Opening
Radius
Center Line of Opening
100% 60% 50% 40% 30% 20% 15% 10% 5%
0 1 2 3 4 5 6 7 8 9
Distance from Face of Opening in Same Units as Opening Diameter
Distance from Center Line in Same Units as Opening Diameter

TABLE II—Recommended Velocities for Exhaust Systems Conveying Dry Dust

Material (dust)	Branch pipe velocity* lineal feet per minute: 2500 to 3000	3000 to 3500	3500 to 4000	4000 to 4500
Abrasives	—	—	X	—
Asbestos	—	X	—	—
Buffing Wheels	—	—	—	X
Carbon and Coke	—	X	—	—
Cast Iron	—	—	—	X
Cement and Lime	—	—	X	—
Charcoal	—	X	—	—
Chrome Ore	—	—	—	X
Clay and Ceramics	—	—	X	—
Coal	—	—	X	—
Cocoa and Chocolate	—	X	—	—
Cork	X	—	—	—
Cosmetics	X	—	—	—
Cotton	X	—	—	—
Feeds and Grain	X	—	—	—
Flint and Feldspar	—	—	X	—
Flour	X	—	—	—
Foundry:				
Blast Cleaning (sand abr.)	—	—	X	—
Blast Cleaning (steel abr.)	—	—	X	—
Sand Handling	—	—	X	—
Tumbling Mills	—	—	—	X
Glass and Cullet	—	—	X	—
Granite	—	—	—	X
Grinders and Polishers	—	—	—	X
Gypsum and Plaster	—	X	—	—
Lampblack and Graphite	—	X	—	—
Leather	X	—	—	—
Limestone	—	—	X	—
Manganese	—	—	—	X
Marble	—	—	X	—
Mica	—	X	—	—
Ore (iron)	—	—	—	X
Oyster Shell (buttons)	—	—	X	—
Pigments	—	—	X	—
Plastics	—	X	—	—
Rubber Compounding	—	X	—	—
Sanders	—	—	—	X
Silica and Quartz	—	—	X	—
Slate	—	—	X	—
Soap	—	X	—	—
Starch	—	X	—	—
Stone and Rock	—	—	X	—
Sugar	—	X	—	—
Talc and Soapstone	—	X	—	—
Tobacco	X	—	—	—
Wood	X	—	—	—

*For average conditions of fineness and loading with normal temperature and moisture content. When applicable, state code requirements supersede the figures specified.

All About Odors . . .

Detection, Analysis, Control

by B. K. Tremaine
Director, New Product Development,
Industrial Reodorant Division,
Rhodia, Inc.

Here's an up-to-date report on fast-moving field of industrial odor control. Author explains use of four ways to control odors caused by chemical fumes, cookers, digesters, and many other industrial processes.

STATISTICS AND SURVEYS of recent years clearly indicate that the general public is very odor conscious. Not only is a pleasant odor paramount when designing new products or selling old products, but it is also important that industrial operations do not emit objectionable malodors.

Odor control products available for both product reodorization and the abatement of odor nuisances from an industrial operation might be classified into four major groups as follows:

1. Masking Agents

Such products are prepared from synthetic aromatic chemicals, their by-products, various essential oils, and chemicals having strong though rather unpleasant odors such as O-chlorophenol, O-cresol, A-naphthylamine, diphenyl oxide, butyric aldehyde, etc. Odor masking based on such materials is described in Market Data [1] as the process of eliminating the perception of one odor or a group of odors by superimposing another odor or groups of odors to create a new odor sensation, preferably pleasant.

2. Odor Counteractants

They are usually prepared from synthetic aromatic chemicals and their compounds, various essential oils, with the addition of perhaps quaternary ammonium compounds or disinfectants. Market Data [1] describes odor counteraction as separate and distinct from the psychological effect of odor masking.

In odor masking strong odors tend to mask weaker ones. If the two odors are about equal strength a blend of the two is observed and both can be identified. If one is considerably stronger than the other, it alone as a rule is perceived.

In odor counteraction certain pairs of odors in appropriate relative concentrations are antagonistic. When the two are sniffed together both odors are diminished.

It is a know fact according to Von Bergen [2] that in the group—benzene, toluene, xylene, pseudocumene, and durene—combinations in the correct proportions from the above group can be produced which are almost odorless.

However, the writer finds very little difference in odor counteractants over masking agents when practical application data is assembled. Both groups require the skill of trained people to obtain the best designed products.

3. Chemical Reactants

Such materials involve the use of ozone, chlorine, chlorine dioxide permanganate, organic peroxides, formaldehyde; or catalytic materials and perhaps bactericides, fungicides, and certain disinfectants.

4. Absorption Materials

Here we have activated carbon, oxygenated sorbents such as silica gel, or activated alumina.

Measurement Requirements Of Masking Materials

The masking compound or counterteractant upon being skillfully chosen can impart definite odor changes at a small percentage to satisfy the sense of olfaction

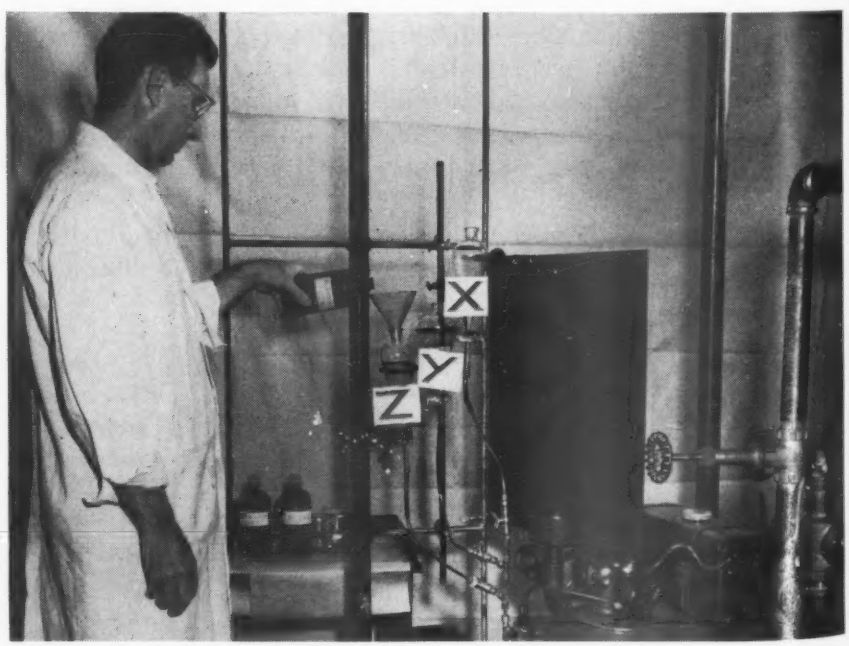

Fig. 1: *Laboratory technician tests effectiveness of new control additive Alamask® on diesel fuel by pouring mixture of the two into fuel line Z. Fuel line X contains standard diesel fuel. Fuel line Y contains different concentration of diesel fuel and additive.*

and thus achieve a desired improvement. The skillful selection involves many important factors before a good odor control product can be obtained.

It is, therefore, important that we know something about these factors. Once they are known it will become obvious to many that the masking concept towards an odor change is not entirely a hit and miss affair.

The desirable odor control product [3] must meet conditions of a chemical nature before it is adequate for an intended application. For example: to abate and mask malodors from sulphate digester cooks, severe requirements of chemical stability impose very great restrictions on useful materials. A properly designed product had to be resistant to the action of a solution of some 5 percent caustic soda and 3 percent sodium sulfide in an autoclave at 170 C.

Of only slightly lesser importance, are the physical properties. A product must be designed to have the right vapor pressure characteristics which is vital for the proper coverage of the malodor being treated. In essence, a good odor control agent within the masking group should be liberated parallel with and in proportion to the malodor.

With these and other definite factors in mind, the producer of aromatic base odor control products must be able to measure in relative terms the odor strength of chemicals so as to discover those which combine the greatest strength with economy.

The most extensive measurement method used in odorimetry is the dilution of clean odorless air with an odorous gas or vapor, until the first often indefinite and vague odor sensation appears.

Simple Estimating Method

This amount of odor stimulus is called the minimum perceptible, or the odor threshold value. It is expressed as the concentration of odorant, preferably in terms of parts per part of air.

We have developed, in preference to this complicated air dilution method, a simple method of estimating various odors, based on diluting odoriferous substances progressively in pure water and smelling the air space above the solutions contained in partially filled glass bottles [5]. The technique corresponds to the methods used for estimation of degree of odor in drinking water[4].

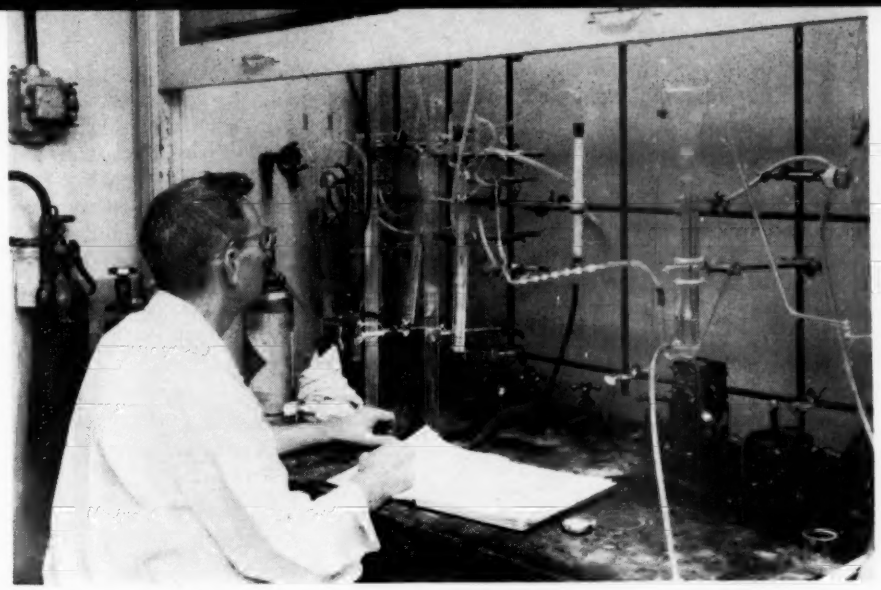

Fig. 2: *Following analytical procedures, technician determines physical properties of product and determines its flowability at various temperatures.*

We have also adopted, as the basis for odor measurement that concentration at which the odor is faintly, but distinctly, recognizable rather than the minimum perceptible which is subject to great error due to indefinite nature and faintness of the first perceptible odor stimulation.

Table 1 lists a few chemicals [5] in descending order of odor content expressed as the concentrations (parts per part of water) which is faintly, but distinctly, recognizable.

TABLE 1 [3]

Chemicals	*Part Per Part of Water*
Hydrogen Sulfide	.004
Methyl Mercaptan	.005
Amyl Mercaptan	.007
Methyl Sulfide	.01
O-Chlorophenol	.03
Pine Oil	.80
O-Cresol	1.0
Camphor	3.0
Carbon Tetrachloride	5.0
Mineral Spirits	8.0

After investigation of strength characteristics, it becomes equally important to those designing products that in applying two products of equal intensity a very different degree of masking or reodorizing effect may be produced. The modified odor might be either less objectionable or unchanged, or more objectionable than the original odor.

Therefore, tests are always necessary to establish the modifying or masking power with respect to a particular malodor under investigation.

Table 2 will illustrate this point. For example: in gasoline, we show the concentration which causes the modification of the initial odor (parts per part of liquid)

TABLE 2

Chemical	*Parts Per Part Gasoline*
O-Chlorophenol	35
Pine Oil	100
Camphor	150

A comparison with Table 1 indicates that gasoline concentrations are considerably higher to cause modification of the initial odor (parts per part of liquid).

Having established a definite order of odor values and the effect for an individual malodorous product, combinations must then be studied and their effects noted. Such testing must take into consideration size of samples, temperature, types of water, solvents, end-use, application details, and stability.

Such tests, working with a dilute solutions say at 1 ppm must be tested within a short time (1-3 hours) because in aging even stable chemicals decrease appreciably in odor strength, probably due to oxidation.

Table 3 shows the stability of Geraniol Extra solution, by storing various concentrations in water for a period up to 50 days at room temperature and then diluting further to establish the scent unit values for the aged solutions.

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Dividing by the number of days of aging the daily increase in odor content can be estimated.

The designer of a suitable odor control product, in formulating products, must take this into account as the final product might have to be used in high dilution for a period of time.

TABLE 3

Geraniol Extra Solution - Stability

Concentration	*Length Of Storage (days)*	*Decrease In Odor Content*
1% in Methanol	50	1%
1% in Water	50	5%
0.1% in Water	50	5-10%
100 ppm in water	12	80%
10 ppm in water	12	100%
1 ppm in water	2	100%

The practical application of odor control products prepared from Group 1 [3] (masking agents) is best illustrated by Table 4.

You will note the variety of uses shown, the malodor to be corrected, and the degree of odor change expected. This is but a small list which if completed would number in the thousands.

The data presented in Table 4 is, of course, subject to operating plant conditions. Each plant operation will vary from another and must be fully understood before the desired effects can be obtained.

Eliminating Odors Chemically

Obviously the elimination of objectionable odors by chemical means is desirable. This may occur especially in air spaces where ozone, H_2O_2, chlorine, formaldehyde, and other chemical agents are made to react chemically with odor bearing substances.

It has been the hope of many to use chemical transformation of odor by interaction between odorous impurities and such destructive agents. An example of this type of approach is the sweetening of gasoline.

There, a comparatively low concentration of highly odorous mercaptans might be caused to combine with reactive vinyl compounds to less odorous sulfides or with reactive carbonyl compounds to mercaptal.

However, when considering large volume gas flows and the need for collection and employment of reactive materials, which in themselves might create pollution problems, the chance of odor elimination narrows down considerably.

There is also the fact that all malodorous compounds which become airborne do not always act the same way but are influenced by many factors. Consequently, some may be less oxidizable than others, can split-off and form unpredictable end-products in atmosphere.

Nevertheless, progress towards odor elimination by chemical means is not entirely held back. Today many of those faced with odor control problems do employ a variety of catalysts which can be helpful in odor control work.

Such products in most cases provide an activated surface on which reaction proceeds more readily than in their absence and when operated properly give predictable results.

For example, the catalytic combustion control for core baking ovens has resulted in less build up of explosive gases, odor and eye

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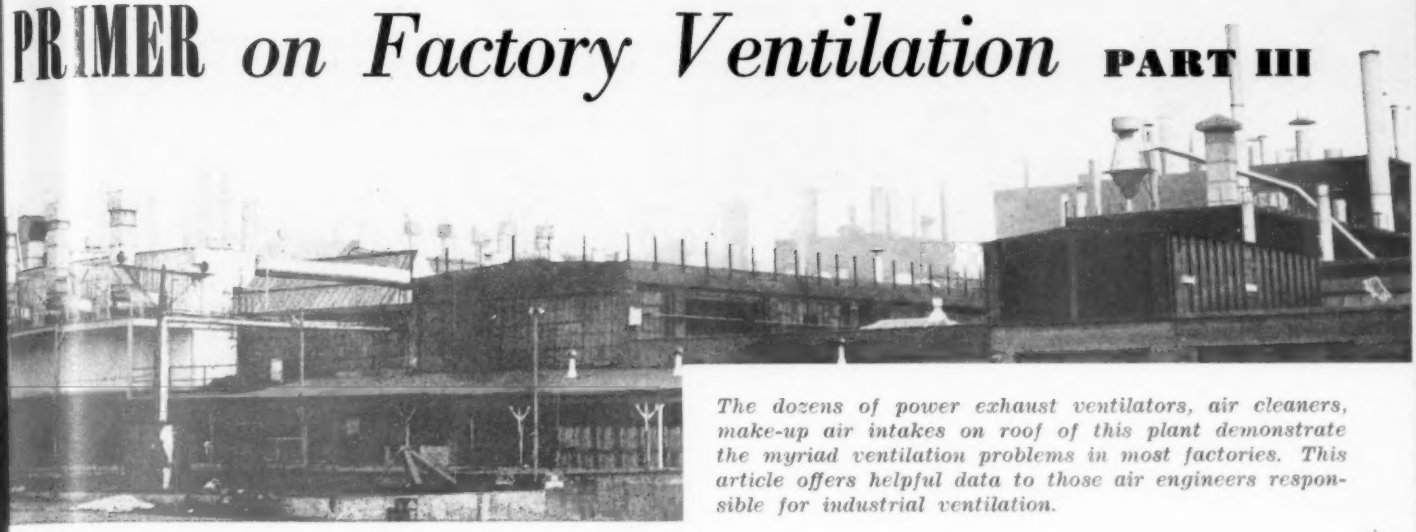
TABLE 4—INDUSTRIAL AIRBORNE MALODOR ABATEMENT

Source-type Malodors	Industry	Odor Change Expected
Digester Fumes—Sulphide odor	Sulphate Pulp	Slight sweetness
Recovery Smelters—Burnt sulfide odors	Sulphate Pulp	Slight sweetness
Ponds, Black Liquor, Sulfide odors	Sulphate Pulp	Abated
Evaporator Condensates, Sulfide odors (high stacks only)	Sulphate Pulp	Abated
Tall oil vapors—Fatty odor	Sulphate Pulp	Soapy-clean
Turpentine vapors—disulphide odors	Sulphate Pulp	Abated
Lime Kiln fumes—sulfide odor	Sulphate Pulp	Abated
Vats, Ponds, Fermentation odor	Beet Sugar Refining	Loss of intensity abated
Vats, Ponds, Fermentation odor	Biochemicals	Abated
Labs, Small Animal Waste odor	Pharmaceutical	Abated
Petroleum: various sources as amines, mercaptans, H_2S, caproics, etc.	Petroleum Refining Petrochemicals	Abated—loss of intensity—neutral sweetness
Chemical Fumes	Chemical Fertilizers	Abated
Condensate Liquors, Fish odor	Manhaden Fish Processing	Abated
Volatile Fumes—Ketone solvent odor	Paint Spray Booths	Abated clean sweetness
Ponds, Amino Acid Waste odor	Chemical Industry	Abated
Sewage: Various Sources as Primary-Secondary Systems—Sulfides	Domestic and Industrial Sewage Plants	Abated, cleaner sweet
Incinerators—Burnt garbage odors	Domestic and Industrial Sewage Plants	Abated
Decomposition Products, Drains, Run-Off, Ponds	Canning Industry	Abated
Digester Cook Fumes, Condensate	Dairy Industry	Abated
Liquors, Grease Tanks, Blood Concentrates, Tankage, Carriers Drum Washing odors	Fat Process Rendering Industry	Abated Cleaner, some sweetness
Spent Mash Fume odors	Brewery Industry	Abated at source
Mercaptan Burnt Fume odors	Reclaim Rubber Industry	Abated by use in scrubbers
Rubber Fume—Exhausts Sulfide odor	Rubber Industry	Abated
Resin Fumes—Odor Formaldehyde	Textile Industry	Abated less irritant
Solvent Exhaust Fume odors	Paints & Varnish Industry	Abated less intense
Waste Mercaptans Spillage odors	Natural Gas Industry	Abated
Coke, Dumps, Lagoon odors	Steel & Iron Industry	Abated loss intensity
Leather Hides—Storage and Shipping —Hide odors	Leather Hides—Processing Industry	Abated cleaner
Urethanes—Ammonium—Fishy odors	Rubber Plastic Industry	Abated loss intensity
Hides—Hoofs Digestion odors	Slaughter Industry	Abated
Animal Waste Fume odors	Mink Farming	Abated
Biotic and Cancerous Waste odors	Hospital Test Units	Abated
Dye Chemical Intermediate Wastes odors, Resin Fume odors	Dye & Chemical Industry	Abated
Diesel Motor Fume odors	Transportation Industry	Abated—loss irritant

PRIMER *on Factory Ventilation* PART III



The dozens of power exhaust ventilators, air cleaners, make-up air intakes on roof of this plant demonstrate the myriad ventilation problems in most factories. This article offers helpful data to those air engineers responsible for industrial ventilation.

Now is the time to get ready for the heating season. Here is helpful data on which of the three basic make-up air systems to use, factors influencing sizing of make-up air units, types of equipment, temperature controls, filtering, air distribution, system numbering and cost factors involved.

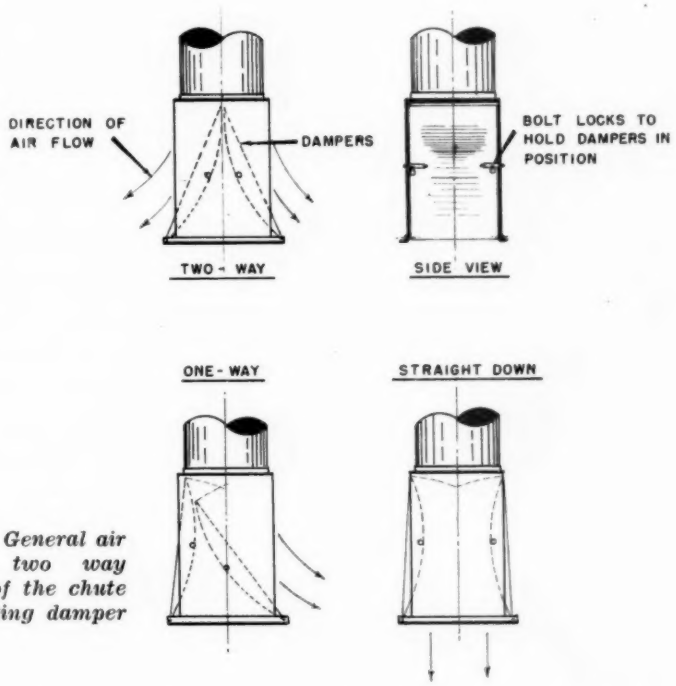


Fig. 15: *General air supply, two way outlets of the chute or directing damper type.*

IN THIS THIRD of the series on factory ventilation, we discuss methods of filtering make-up air, temperature control systems, and air distribution techniques.

Make-up air should be filtered to prevent contaminant from reentering the building. Normally, of course, collection equipment should be provided to control emissions to the atmosphere. Such equipment, however, is seldom 100 percent efficient and some dust, lint, fly ash, etc., is always present in the air.

It is also a fact that contamination within an area cannot be less than the air being returned or supplied to an area. A further reduction in contamination is possible only by providing air cleaning facilities to the present make-up air equipment.

Various methods of cleaning air can be resorted to depending on cleanliness desired, such as:

1. *Replaceable filters.*
2. *Washable filters.* This type of arrangement is becoming increasingly popular, especially since cleaning services on an exchange basis are very reasonable.
3. *Air washer, spray or capillary.* Air washers have the advantage of providing evaporative cooling as well as filtering, although not as efficient as some other mediums. Cooling by evaporation is a simple inexpensive way of cooling outdoor air for spot cooling hot operations. The capillary air washer is somewhat more effective than the spray washer in lowering temperature. However, in areas where cupola fly ash or iron dust prevails, its use is not recommended. This material will not readily wash through the cells but instead accumulates and hardens into a mass, eventually completely blocking air flow.
4. *Continuous oil bath filter:* This continuous automatic traveling screen type filter has enjoyed wide application in industry. Although quite effective, oil carryover has been one of its draw backs, a condition caused by heavy dust loading on the screen. The resulting oil in the ductwork can be a hazard and presents a problem in housekeeping.
5. *Dry media roll filter:* A wide selection of dry media filters is being offered for various applications. The media is usually stored in a roll and advanced across the air stream by a combination of timer and pressure differential.

Most serious drawback to these units has been difficulty with media becoming caught or slipping clutches preventing media advance. This filter has very definite advantages over the oil bath type in that there is no dirty oil to contend with, no fire hazard and no odor problem.

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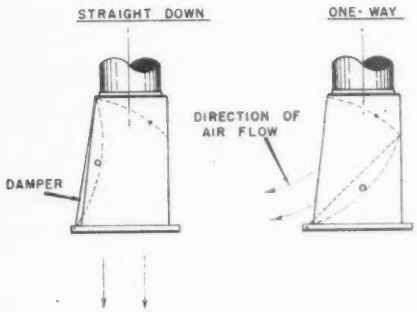
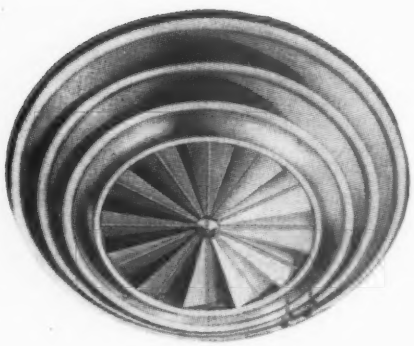
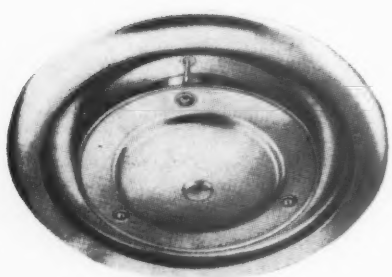


Fig. 16: *General air supply, one way outlet of the chute or directing damper type designed for wall outlets.*





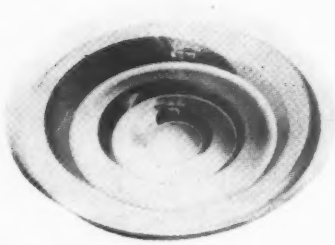


Fig. 17: *Typical air diffusers of the adjustable type to blanket entire areas.*

(Continued from preceding page)

6. *Electrostatic precipitator:* This type of cleaner is extremely effective, removing smoke, odors, pollen, etc., and for this reason is more often used for office supply systems or other areas where extreme cleanliness is required.

Many of the problems involving make-up air cleaning can be avoided by effective collection equipment on discharge stacks, and by locating air intakes away from such stacks, ventilators, and open monitors. A little extra time and effort spent in locating and grouping stacks and intakes will be repaid many times in reduced maintenance and cleaning of make-up air filters.

Temperature Controls

Whenever make-up air is tempered it is extremely important that temperature controls be provided to maintain constant conditions. Temperature controls can be classified as pneumatic, electric, electronic, and liquid filled. All give satisfactory results when proper application is made.

The liquid filled type is the simplest control in both initial installation as well as operation. For that reason it should be given special mention in connection with make-up air systems. Numerous controls of this type have been installed on steam units with very satisfactory results. These controls are completely installed by the plumber since no electrical wiring is required.

The most important single item, so far as satisfactory temperature control is concerned, is the location of the controlling thermostat. Basically there are two locations for the controller, in the room or in the supply duct. Both have very definite merits.

Room thermostats sense actual conditions existing at the thermostat and will tend to compensate for changes, calling for additional heat upon temperature drop and less heat when temperature rises.

However, when the conditions at the thermostat are not representative of the conditions throughout the entire area served by the unit being controlled by this thermostat, difficulties and complaints will result. The thermostat will be demanding heat when perhaps some areas already are too warm, or vice-versa.

A typical experience in a foundry illustrates the troubles that can result from room thermostats. It so happened on a Monday morning that temperatures were considerably below normal and one of the core room employees had a hot rack of cores set nearby to provide him with additional heat.

The entire area (except the employee near the warm rack of cores) quickly became chilled. First thoughts, of course, were a steam shortage or possibly a trap failure. A chance check of the thermostat, however, led to discovery of the hot core rack nearby and the problem was quickly solved.

Similar but less obvious influences can, at any time, disrupt an entire area being controlled by a room thermostat. Relocation of the controller will sometimes correct a bad condition, but even the best location can lead to difficulties when uneven temperature influences exist.

As a result of difficulties with room thermostats, all make-up air units now being installed at one plant are equipped with duct stats, and numerous older units are being converted.

This arrangement results in constant temperature air being delivered to the area. Furthermore, local influences have no effect, and the controller is not readily accessible for tampering or damage.

The controllers are merely set at whatever temperature best suits the overall requirements, with supplemental equipment such as small unit heaters or fans relieving extremely variable areas within the system influence.

Also if the volume of make-up air is quite large, providing a high ventilation rate, the entire area will tend to approach the temperature and condition of the air being supplied and local influences will be minimized.

Control Selection

The following items are important in selection and installation of temperature controls:

1. The normal setting of the thermostat should fall at or near mid-range. If normal settings are near the low range, the action will be too easily influenced by building vibration.

2. Thermostats should be readily accessible by authorized personnel and should be isolated from vibration as much as possible.

3. To prevent over running and excessive modulation, modulating motors should not act too fast or

should preferably be equipped with speed control.

In the entire field of make-up air no item is as important to satisfactory system operation and its acceptance as the location and type of outlets and the training of personnel in their use. Unless all outlets are open so the system can deliver full design volume, the equipment cannot fulfill its function. It is of utmost importance that outlets can be adjusted to meet all possible requirements but cannot be closed off.

Types of Outlets

A type of outlet that has proven quite satisfactory in one plant is the chute or deflecting damper type, (Fig. 15 and Fig. 16). This outlet control was developed mainly for general supply outlets located along main building columns. These outlets originally were simply Y's directed to both sides of the column toward the conveyors or work areas.

The Y's were quite satisfactory as long as personnel wanted this air blowing toward them; however, when this arrangement became uncomfortable, the only alternative was to close off the outlet, at the same time closing off this air supply.

As these outlets were closed off one at a time, the outlet velocity at the remaining outlets increased to the point where they, too, had to be at least partly closed off. The result was that these general supply systems with a capacity of 80,000 cfm were sometimes able to supply less than 25 percent of this volume. It was also obvious that to make further expenditures for supply systems under these conditions was extravagant to say the least.

As indicated in Fig. 15, the two-way outlet can be set to discharge evenly to each side, entirely to one side, straight down, or any desired intermediate setting, but cannot be closed off. The one way outlet type (Fig. 16) was designed for wall outlets to allow discharge toward work areas, straight down near the wall, or any intermediate setting.

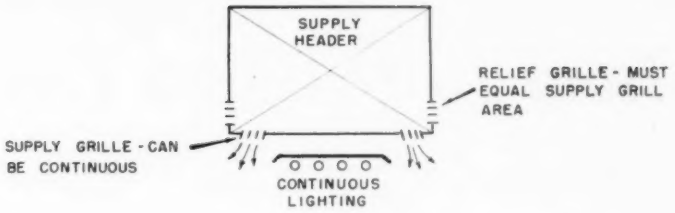
Several types of circular diffusers are also in use throughout many foundries, (Fig. 17) many on systems which blanket entire areas where operations are frequently shifted. During winter months these outlets are adjusted for fairly high level distribution to avoid drafts. During summer months the outlets are set for almost vertical discharge to provide air movement.

Another application of the round diffuser has been for supply to individual operators, where operations are scattered without pattern.

Various types of adjustable outlet grilles are also being successfully used to supply make-up air especially to inspection belts and small parts chipping and grinding operations, (Fig. 18 and 19).

Individually adjustable grille bars provide a wide range of adjustment to suit varying conditions and individual requirements. Because the grilles are usually very close to the operator, velocity is very critical. To provide additional possible velocity range as well as to allow complete shut off, duplicate relief grilles are provided along the side of the header. These also allow supply into the area without discomfort to the operators. Design velocity range of the supply grilles is 500 to 675 fpm, the high being attained with all relief grilles closed while the lower is with all supply and relief grilles open.

Next Month, Part IV. ▲▲



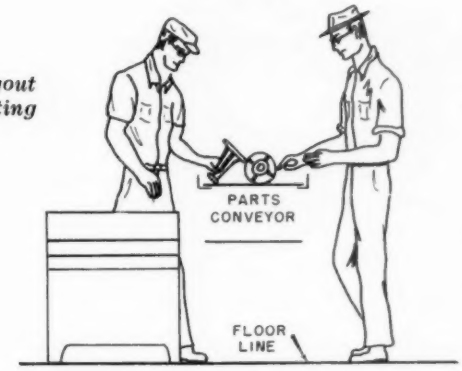
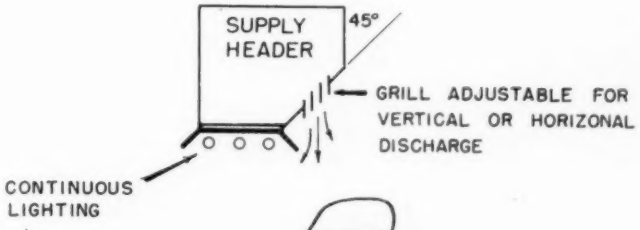


Fig. 18: *Fresh air layout for typical small casting inspection belt.*



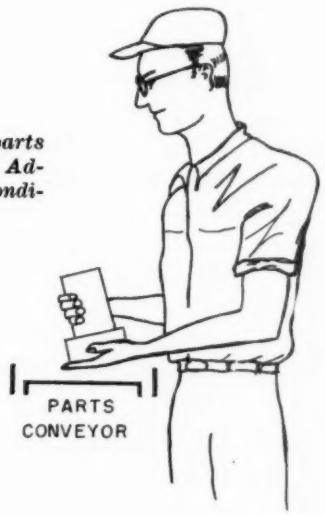


Fig. 19: *Outlet grille for small parts chipping and grinding operation. Adjustable grille bars meet varying conditions.*

How To Design a Low-Cost Anodizing Tank Vent System

by Lawrence C. Curley
Industrial Hygienist
Health Department, Detroit

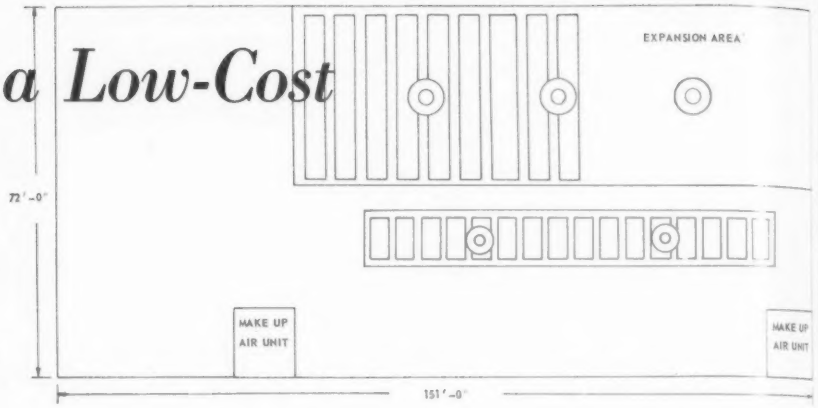


Fig. 1: *Plan view of anodizing tanks in Detroit plant*

Analysis of three solutions to their ventilation problem saved this firm $6000 to $10,000. Here's a dollar and cents comparison of slot type down-draft exhaust hoods vs push-pull system vs canopy hoods overall.

A UNIQUE, YET EFFECTIVE ventilation system has been in operation at a Detroit anodizing plant for the past two years. The problem management faced upon leasing the present location was how to ventilate process tanks with the following conditions:

(a) The processing tanks were 32 ft. long by 4 ft. and 5 ft. wide by 5 ft. deep.

(b) An older building was leased with limited floor space.

(c) An overhead twin-hook hoist was required to handle the work pieces in the process tanks.

The following tanks required ventilation either for health reasons or to remove nuisance moisture (important in this case because the condensation "drops" spotted the finished product).

Quantity	Process tank	Size (ft.)
	Anodize line	
1	Soak clean	32 x 4
1	Caustic etch	32 x 4
1	Anodize	32 x 5
1	Hot water seal	32 x 4
	Miscellaneous line	
1	Bright-Dip	8 x 4
1	Soak clean	8 x 4
1	Caustic etch	8 x 4
1	Hot water seal	8 x 4
1	Chromic acid anodize	8 x 4
1	Potassium Dichromate seal	8 x 4
9	Dye tanks	8 x 4
1	Nickel acetate seal	8 x 4

These methods were considered for providing the ventilation:

(a) Using slot type down-draft exhaust hoods on each side of the tank. "Capturing" a contaminate is difficult when released beyond 2 ft. from slot opening in an exhaust hood. Exhaust requirements would be designed for 200 cfm/sq. ft. of tank surface for all process tanks.

(b) Using a push-pull system with downdraft hoods on one side of the tank with a pressure (push) hood or pipe on the oposite side. The "pull" or exhaust hood designed for 100 cfm/sq. ft. of tank surface with "push" supply approximately 5 percent of the exhaust total.

(c) Two canopy type hoods over entire area. This is the method that was finally used. See Figs. 2 and 3.

Discussion of the Three Methods:

(a) Using slot type down-draft hoods and 200 cfm/sq. ft. of tank surface would require exhausting approximately 200,000 cfm; the hoods and duct work (on the floor) would use valuable floor space. Approximate cost of equipment and installation is $23,000. These figures do not include the make-up air units.

(b) Jsing the push-pull system and 100 cfm sq. ft. of tank surface would require exhausting approximately 100,000 cfm. The push-pull hoods and duct work would require less floor space than method (a). Approximate cost of equipment and installation is $19,000.

(c) Two canopy hoods constructed of 20-gauge sheet metal panels enclosed the entire area of process tanks. Using only two of the 42 in. fans in the large anodizing tank area and the 36 in. fans in the miscellaneous tank area, approximately 102,000 cfm is exhausted. As seen from the sketches, there is no wasted floor space. Approximate cost of equipment and installation is $13,000.

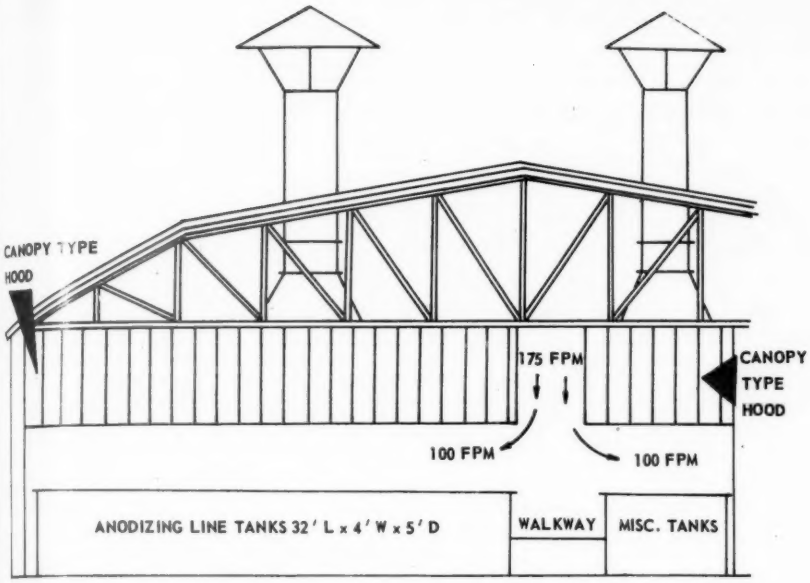


Fig. 2: *Side view of the plant showing air flow in canopy hood system.*

Airflow measurements made along the walkway with a velometer varied between 100-175 fpm.

During the first year of operation, employes experienced discomfort due to drafts and difficulty in opening and closing doors. This was caused by the negative pressures in the building.

This condition was relieved by the installation of two make-up air units. These units were a gas-oil fire combination and had a total air capacity of 76,000 cfm. Since the installation of these make-up air units there has been no employe complaints.

Design Discussion:

1. In this canopy hood system, clean, fresh air is swept past workers on the walkway in the 100 fpm to 175 fpm velocity range.

2. The fresh air streams on walkway are sensitive to cross drafts, so it is necessary to keep outside doors and windows closed or better still, isolate this type of operation. If large doors are used near this type of operation, they should be of a type which can be easily closed when not needed. ▲▲

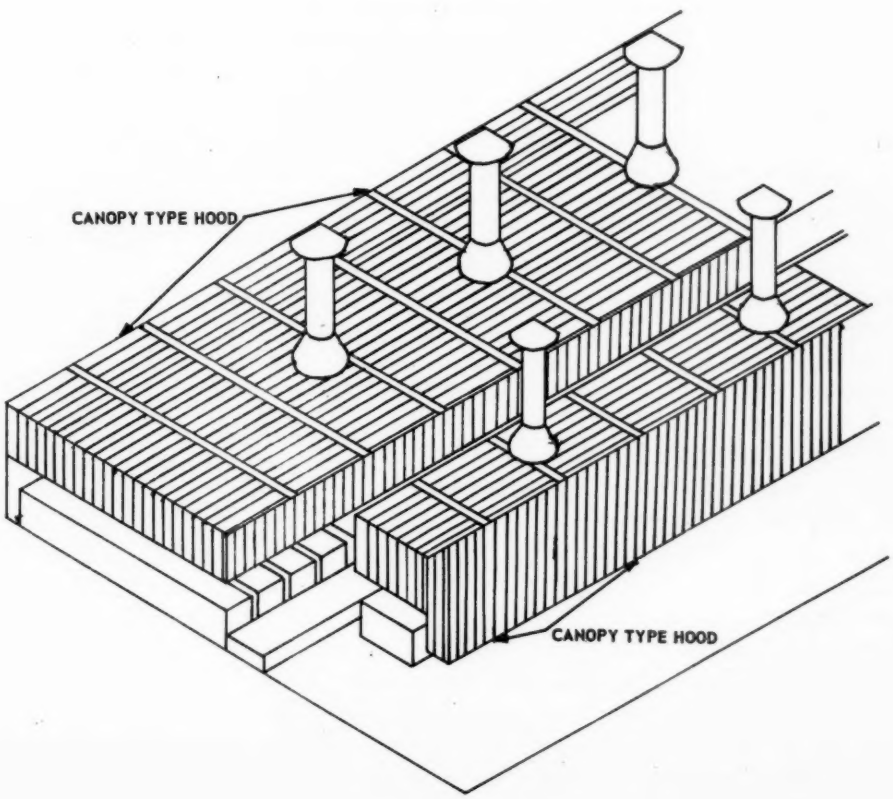


Fig. 3: *Perspective view of canopy hoods covering entire area of anodizing tanks.*

Sprayed coil dehumidifiers offer air engineers . . .

5 Ways To Cut Cooling System Costs

by J. R. Welch
Sturtevant Division
Westinghouse Electric Corp.

When designing air conditioning and winter humidification systems, this round-up of sprayed coil dehumidifier applications can help you reduce equipment size, operating and installation costs, simplify control set-up.

IN MANY INSTANCES the apparatus which makes possible the successful application of basic components of an air conditioning system – compressors, chillers, and air distribution units – and permits their efficient and economical operation is a product which is generally overlooked – the sprayed coil or surface dehumidifier . . . "the forgotten tool" of central air conditioning system design.

What Are Surface Dehumidifiers?

Surface dehumidifiers consist of a bank of direct expansion or chilled water extended surface cooling coils mounted in a factory-built spray chamber which is supplied complete with tank, moisture eliminators, and provision for a recirculated water spray pump.

A bank of spray nozzles is arranged to spray recirculated water uniformly in the direction of air flow over the coil face area at the rate of 1 gpm/sq. ft. The momentum of the air stream carries the spray water through the coils wetting the entire coil surface. The moisture eliminators trap entrained moisture and prevent carry-over with the leaving air stream.

What Do Surface Dehumidifiers Do?

For air conditioning applications, surface dehumidifiers, at lower first cost and lower operating cost, practically duplicate the performance formerly obtained from saturation-type dehumidifying air washers.

Surface dehumidifiers will provide practically saturated leaving air and thus lower leaving dry bulb temperatures. This reduces to a minimum the quantity of air necessary to absorb the air conditioning load. As an example consider the following:

Assume a direct expansion coil operating at 500 fpm coil face velocity with 84 F DB and 70 F WB entering air, 45 F refrigerant evaporating temperature in the coil.

The air conditions leaving an unsprayed coil would be 61.8 F DB and 59.1 F WB. If the same coils were installed in a surface dehumidifier, the recirculated water spray would lower the dry bulb temperature from 61.8 F to 59.5 F. This means an added dry bulb temperature reduction of 2.3 F or 10.4 percent $100 \times \left[\frac{61.8 - 59.5}{84.0 - 61.8}\right]$.

For the same sensible heat removal requirement a surface dehumidifier, in this case, would permit a reduction of 10.4 percent in circulated air volume.

Reducing the required quantity of air to a minimum in this manner results in smaller equipment and smaller ducts. Smaller fans, grilles or inductor units mean less cost and lower fan horsepower; smaller ducts mean lower first cost and less expense to install and insulate.

Furthermore, the supply of practically saturated air makes the use of air inductor units feasible in many installations.

Simple Control

Unsprayed coils in built-up systems or in air distributing units give control of either wet or dry bulb temperatures but not of both at the same time. Air

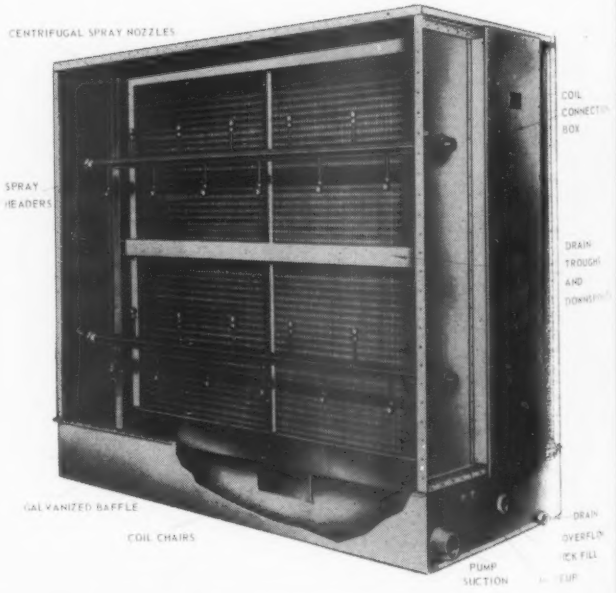


Fig. 1: *Surface dehumidifier, entering air side.*

washers with temperature control of the spray water give dew point control to obtain both design dry bulb and wet bulb temperatures within the space.

Since a surface dehumidifier practically saturates the leaving air, simple and effective dew point control can be obtained by a thermostat in the discharge air stream. This gives ideal control for either high or low-pressure air inductor units, for modern discharge grilles, and also for industrial applications requiring control of both temperature and humidity.

Evaporative Cooling

In addition to the beneficial operation for cooling and dehumidifying, surface dehumidifiers have other operating advantages. For instance, without any cooling medium circulating in the cooling coils, operation of the sprays results in an evaporative cooling effect – tending to saturate the air at the entering wet bulb temperature.

This evaporative cooling effect can be used in mild weather and in the spring and fall to provide cooling without operation of the refrigerating equipment. It frequently saves considerable operating expense, particularly if the electric power rates include demand charges.

Winter Humidification

Surface dehumidifiers primarily installed for cooling and dehumidifying also can be used to provide humidification during the heating season giving the benefits of complete year-round air conditioning. When operating to provide humidification, recirculated water is sprayed over the cooling coils, thoroughly wetting the extensive heat transfer surface.

Air, heated by preheating coils, passing through the spray and over the wetted surface, absorbs water and leaves the cooling coils reduced in dry bulb temperature due to the evaporative cooling effect. Reheaters may be used to heat the air to meet the space requirements.

Humidification can also be obtained by heating the spray water. Air entering the sprayed coil unit should be at a minimum temperature of 35 F to prevent freezing. Due to the limited amount of heat that can be absorbed by the spray water from the heater, preheaters are usually operated to give higher leaving air temperatures.

Spray water heaters are selected to saturate the air passing through the surface dehumidifier at the space dew point temperature. Air leaving the sprayed coil section must be reheated, of course, to provide for the space heat loss.

Heat Transfer

Since surface dehumidifiers are highly efficient thermodynamically, they are the ideal heat transfer apparatus between the refrigeration system and the circulating air system. Cooling coils can be selected to take full advantage of the capabilities of the refrigeration system whether it is direct expansion condensing unit, a packaged water chiller, a centrifugal refrigerating system, or a steam absorption refrigerating system. Water coils can readily be selected for low or high water temperature rise to provide system flexibility.

Modern air distributing grilles and air inductor units can be selected to take full advantage of the ability of the surface dehumidifier to supply practically saturated air resulting in high over-all performance with marked savings in fans, fan motors, sheet metal duct work, insulation, and air outlets.

Operating Advantages

In addition to the flexible performance of surface dehumidifiers there are several operating advantages over equipment that can perform only some of their functions. For instance, water sprayed on the cooling coils flushes dust, dirt, lint, etc. from the coils, continuously eliminating sources of objectionable odors and providing continuing high original performance.

Safe control of humidification is easily obtained with a simple thermostat controlling the steam supply to the preheating coil when recirculated water is sprayed over the cooling coils. Contrast this with the hazard of a steam grid humidifier running wild due to faulty control.

Conclusion

Often the performance and operating advantages of surface dehumidifiers have been overlooked or casually dismissed. The fact is that surface dehumidifiers frequently permit the most economical system design. ▲▲

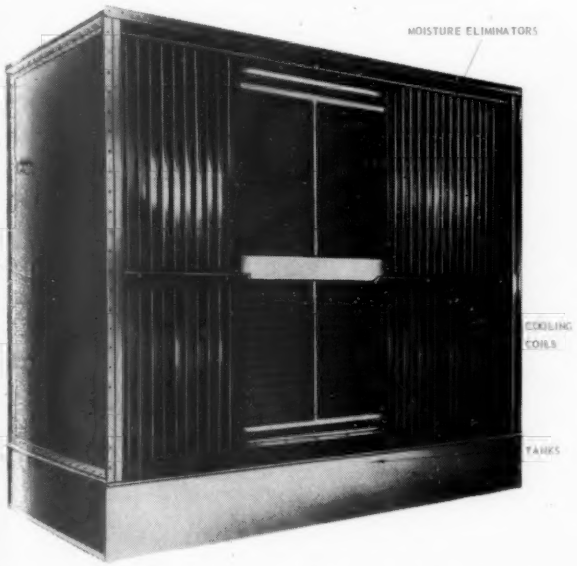


Fig. 2: *Surface dehumidifier, leaving air side.*

Do You Store or Handle Volatile Liquids? Here's How To . . .

Cut Evaporation Losses with Floating Roofs

by Ralph E. Kramer
Vice President, Hammond Iron Works

This description of five tank storage devices explains how they can save up to 4% of your product, reduce tank corrosion and fire and explosion hazards.

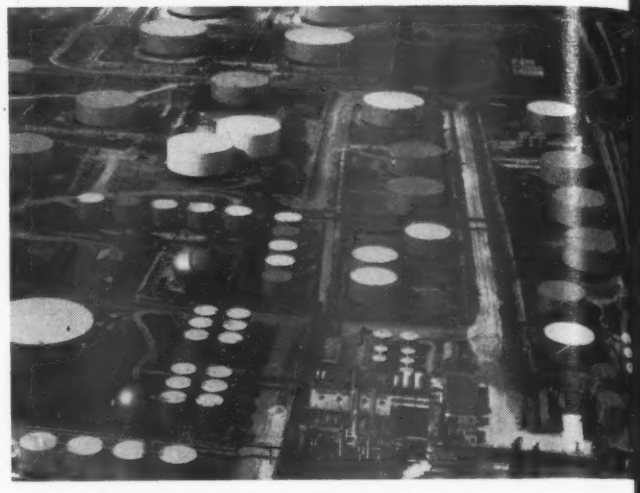


Fig. 1: *Storage tanks containing volatile liquids represent serious air pollution problem. Conservation type tanks can overcome this problem.*

A MAJOR CONTRIBUTION to the problem of air pollution is the evaporation of volatile industrial liquids from vented storage tanks. When one considers the vast number and quantity of products produced and stored in the liquid state the need for more rigid control of evaporation losses becomes obvious. To add insult to injury these evaporation losses cut deeply into company profits. For instance, it has been estimated that approximately 3 percent of all petroleum produced in the United States is lost through evaporation.

This amounts to almost $300,000,000 per year. It also represents a sizable contribution to air pollution – approximately 70-80 million barrels of petroleum products released to the atmosphere. Add to this the many millions of gallons of released vapors contributed by the chemical, paint, dry cleaning and other industries storing volatile liquids and you get a fair conception of the seriousness of the problem.

Unlike solid pollutants such as dust, fly ash, smoke, etc., the vapors escaping from storage tanks are almost always invisible and consequently they escape visual detection. Perhaps it is this invisibility that is responsible for the general neglect of evaporation losses. With the continual expansion of the process industries resulting in more extensive production and storage of volatile products, it is important that more serious consideration be given to the problem of air pollution by escaping vapors.

American Petroleum Institute, the Bureau of Mines and other organizations have spent considerable effort to focus attention on the seriousness of evaporation losses. In addition, air pollution control committees have been putting pressure on refineries to keep hydrocarbon vapors out of the air. That an effective job can be done to reduce evaporation losses has been proved by several large oil companies. One leading refinery cut overall evaporation losses from tankage 70 percent by replacing cone roof tanks with floating roof tanks. Others have had similar experience.

Causes of Evaporation Losses

Evaporation is the physical phenomenon in which a liquid changes into the vapor or gaseous state. Molecules of liquid escape from the surface to the atmosphere. The number of molecules escaping – or the rate of evaporation – is affected by the surface temperature of the liquid, the amount of vapor above the liquid, the liquid surface area and the renewal of air above the liquid. If the liquid is contained in a closed vessel, evaporation will continue only to the point where the number of molecules escaping from the liquid equals the number being returned to the liquid. The pressure above the liquid when this state exists is the "vapor pressure" at the particular temperature. The vapor space under these conditions is said to be saturated. However, if vapor is allowed to escape through a vent, evaporation will continue, since saturation cannot occur. Such is the condition in the ordinary cone roof storage tank.

A typical example of the nature and extent of evaporation losses from a cone roof tank might be as follows:

A 100 ft. diameter, 40 ft. high tank has a capacity of 55,000 barrels of gasoline. It is filled with liquid until only a small vapor space remains above the

liquid. The tank will be subject to fluctuations in temperature during a 24 hour period. When the temperature rises the vapor pressure increases, the vent opens and vapors escape. When the temperature drops vapor condenses, reducing the vapor pressure inside the tank. Air is then sucked into the tank through the vent. When the temperature rises again more vapor will form to occupy the air space. When liquid is withdrawn from the tank the vapor space above the liquid increases, changing conditions of equilibrium and permitting more vapor to escape from the liquid surface. When the tank is filled again this vapor is pushed out through the vent.

The escape of vapor due to temperature fluctuation is generally called "breathing loss", the escape of vapor due to periodic emptying and filling the tank is termed "filling loss". In the tank described above these breathing and filling losses can amount to more than 1,900 barrels/yr. or almost 80,000 gals.! With products of higher vapor pressure the loss would be even greater.

Combatting Evaporation Losses

There are three practical ways in which evaporation can be drastically reduced or eliminated:

1. By preventing vapor from forming
2. By storing the vapor in a variable volume space
3. By confining the vapor under pressure

These preventative techniques are applied in the design and construction of various types of conservation tanks. Tanks described below include floating roof tank, diaphragm tanks, expansion roof tanks, pressure tanks and plastic covers. Conservation tanks reduce evaporation losses by as much as 95 percent.

Floating Roof Tanks

The floating roof tank (Fig. 2) prevents vapors from forming by eliminating the vapor space above the liquid surface. This type of tank eliminates both breathing and filling losses, whereas pressure tanks and variable volume tanks eliminate only breathing losses. Additional advantages accruing from the elimination of vapor formation by floating roof tanks are a minimization of fire and explosion hazards, prevention of tank corrosion and preservation of product quality.

The floating roof tank is used primarily for large volume storage of any volatile liquid which does not boil at storage temperatures.

Two types of floating roofs are in general use — the pan type and the pontoon type, including the double-deck roof.

Pan Type Roof

The pan type (Fig. 2a) is the earliest of floating roofs and while its simple construction and low cost have made its use attractive from an economic standpoint, it is recommended for use only in mild climates where snow, ice or high winds are not experienced. The pan roof is essentially a simple pan and a rim floating directly on the surface of the liquid. A major advantage of the pan roof is the direct contact with the liquid surface thereby reducing or eliminating corrosion of roof plating in storage of crude oil or other products which are corrosive in contact with air.

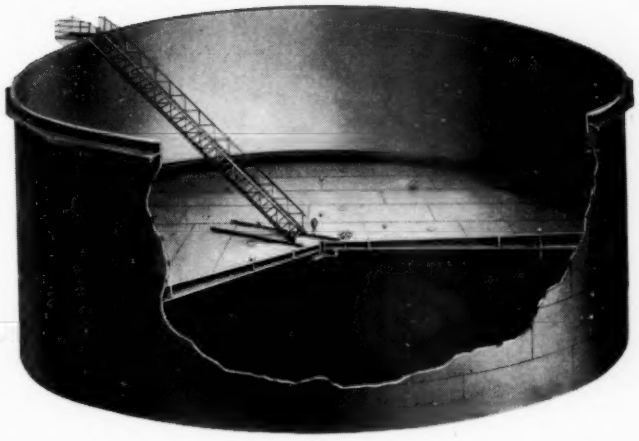


Fig. 2: *Floating roof tank for product conservation.*

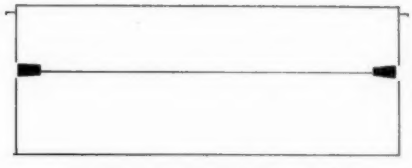


Fig. 2a: *Pan type roof.*

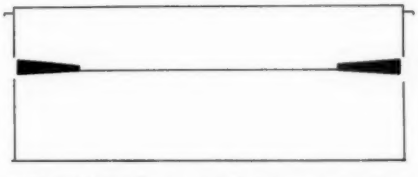


Fig. 2b: *Segmental pontoon roof.*

Fig. 2c: *Double deck pontoon roof.*

Pontoon Type Roof

Greatly improved stability under snow and rain loads is achieved in the floating roof by the use of annular compartments or pontoons to increase the buoyancy over that provided by the pan type roof. There is less tendency for boiling to take place with

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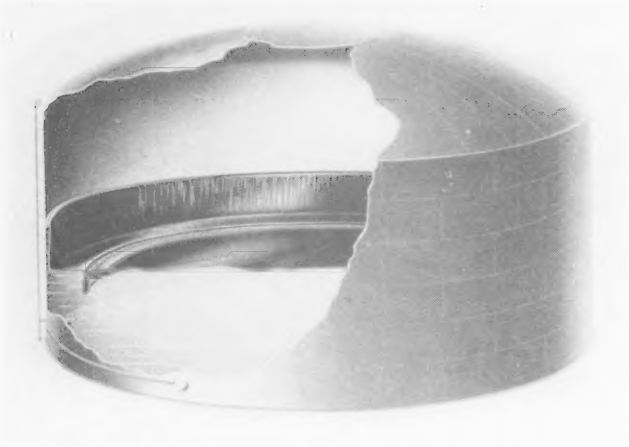

Fig. 3a: *In the Hammond Diaflote tank the flexible diaphragm always floats on the surface of the liquid.*

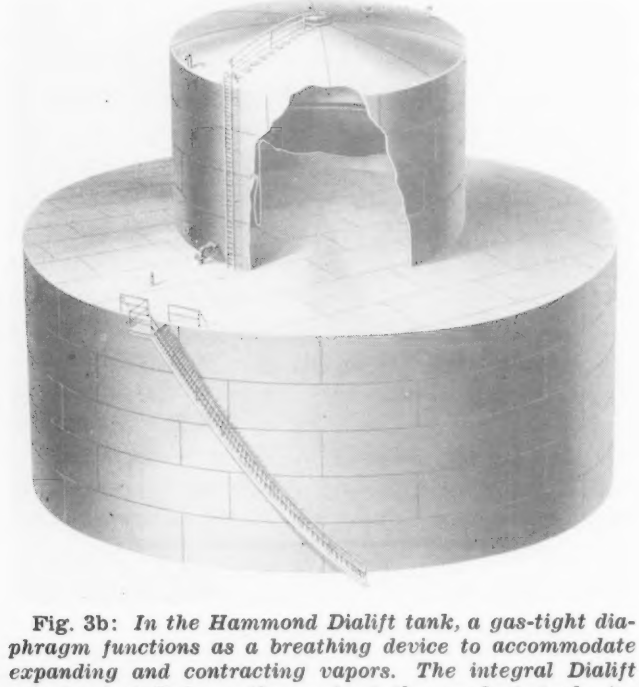

Fig. 3b: *In the Hammond Dialift tank, a gas-tight diaphragm functions as a breathing device to accommodate expanding and contracting vapors. The integral Dialift can be installed on the roof of the product tank (as shown) or in an independent housing manifold to one or more product tanks.*

(Continued from preceding page)

the pontoon floating roof. The pontoon area, which may vary from 20 percent to 100 percent, provides an insulating covering of air, minimizing surface boiling due to exposure to solar heat. The double deck type of pontoon roof (Fig. 2c) consists of two separate decks providing 100 percent insulating space over the entire liquid area. This roof is more rigid and contains greater stability than the other types. The double deck roof is the most efficient and one of the most commonly used types of floating roof construction.

Segmental Pontoon Roof

A more economical type of pontoon floating roof is the segmental pontoon roof, (Fig. 2b) which provides maximum buoyancy with a minimum of material. It offers an insulating covering of air over a portion of the liquid surface and at the same time keeps the entire lower surface in contact with the stored product. The segmental pontoon roof is recommended for tanks used to store less volatile but more corrosive products, where it is desirable to eliminate air space below the deck in order to minimize the possibility of corrosion.

A floating roof is only as effective as the seal between the floating roof and tank shell. Without a permanent close contact between the roof shell a vapor-tight seal cannot be assured. There are two types of seals – the rugged, mechanically simple metal-shoe seal and the maintenance free flexible seal.

All types of floating roof tanks can be installed in new or used tanks of either welded or riveted construction.

Diaphragm Tanks

Diaphragm tanks use a flexible, gas-impervious diaphragm to prevent evaporation. In one model, the Diaflote tank, the diaphragm (Fig. 3a) is attached to the tank shell and shaped to fit the inside wall and the bottom of the tank. The diaphragm rests on the surface of the liquid and provides a vapor and liquid-type seal between the stored product and the air space above the diaphragm.

Another model, the Dialift tank, consists of a steel enclosed variable volume space superimposed on a standard cone roof tank as shown in Fig. 3b. The diaphragm lifts under slight pressure when additional vapor space is required and lowers when less vapor space is needed. The size of the vapor holder and diaphragm determines the amount of expansion available. The vapor space of several fixed volume storage tanks may be interconnected to a single Dialift tank which if properly proportioned can reduce all breathing losses in the system. The tank may also be located apart from the main tank at ground level and is then referred to as a ground Dialift.

The diaphragm tanks are recommended for storage of volatile, high purity, deaerated, corrosive and inflammable products. The Dialift tank is used for capacities up to 150,000 cu. ft. of vapor storage. The liquid storage tank itself can be any commercial capacity.

Expansion Roof Tank

In the expansion roof tank such as the Vapor-Lift tank, the roof functions as a "lung" to store the vapors generated in the tank or in other tanks to which it might be connected. Under normal con-

ditions the Vapor-Lift roof will rest on the roof supports as in a conventional cone roof tank.

As the vapor pressure in the tank increases, the roof will rise to make room for the increased vapor. It will lower when the vapor pressure decreases. The variable vapor space is liquid-sealed to prevent the escape of vapors. Breathing losses are eliminated, filling losses reduced and the quality and quantity of the stored liquid maintained. Vapor-Lift tanks are made to capacities of 100,000 barrels.

Pressure Tanks

Vapor loss can be prevented by storing under pressure. Several types of pressure tanks are available. Low pressure tanks (for pressures up to 25 psi) include the single globoid, double globoid and ellipsoid tanks. For higher pressures spheres are used.

Plastic Covers

A large portion of the total annual evaporation loss and air pollution occurs from small diameter vertical storage tanks used for lease storage, production, and marketing of gasoline, for solvent storage and for related industrial liquids. These tanks range in size from 10 ft. to 20 ft. in diameter, have fixed roofs, and are generally not equipped with conservation vents. Frequently, these tanks require floating roof protection so that a substantial proportion of the losses may be eliminated.

Small floating roofs constructed from steel are not economical for this type of service. Hammond Iron Works has introduced a low cost rigid foam plastic floating roof called the HAMONDFLOTE cover illustrated in Fig. 4. This cover is constructed of rigid polyurethane foam, a plastic material with exceptionally low density and high load carrying capacity.

The cover is made in 18 in. wide radial segments. Each segment has a flexible synthetic foam seal attached to its periphery. When all segments are assembled the synthetic loop provides an excellent edge seal. The pie-shaped segments area easily inserted through the roof manhole for installation while the tank is still in service. The radial sections are readily assembled with slip-fit joints to form the completed roof.

The rigid foam plastic cover will provide the same protection from evaporation for small tanks that the floating roof accomplishes for large storage tanks. Evaporation, breathing and filling losses can be reduced at least 90 percent with the use of the Hamondflote cover. Because it prevents the formation of vapor and exposure to air, the plastic cover offers the additional advantages of safety and product stability.

Other Factors Involved In Evaporation Losses

There are several additional factors to consider in preventing or reducing evaporation losses. These include the following:

a. Prevention of leaks from relief valves

b. Use of conservation type vent valves

c. Painting tank with light colors to reduce solar heat impact

d. Cutting down on number of openings for gaging, etc.

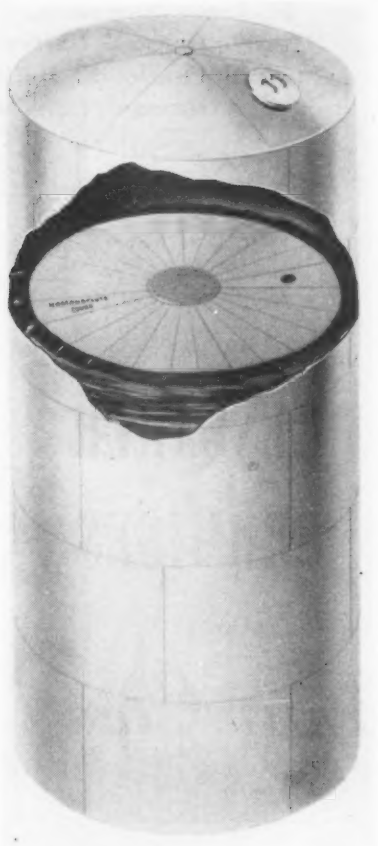

Fig. 4: *Schematic drawing of the Hamondflote cover in small diameter, vertical storage tank.*

Are Your Tanks Contributing To Air Pollution?

If you are storing a volatile liquid in an open vented tank you are losing product to the atmosphere. How much these losses will amount to in a year will depend upon your particular atmospheric conditions, the frequency of turnover of product, the volatility of the product and other factors.

Perhaps your records of incoming and outgoing liquid will indicate the losses incurred during the year. Without getting involved in laborious computations you can rest assured you are losing from 2 to 4 percent of your product, and in some cases even more. Conservation type tanks are the answer to the problem of evaporation losses. Your best bet to determine the type of tank required for your storage problem is to contact one of the leading manufacturers of conservation type tanks. ▲▲

by Leslie Silverman, ScD
Harvard University
and Charles E. Billings
Harvard University

RESEARCH PROMISES . . .

Low Cost Cupola Dust Collector PART IV

ABSTRACT

Many processes produce fine particles (0.5μ) suspended in gases at 1000 F or higher, and in current practice temperatures are reduced to utilize available commercial gas cleaning equipment such as electrostatic precipitators, bag filters, etc. Due to high costs of present cleaning methods and increased use of higher temperature operations, there exists a need for devices which will clean gas effectively and inexpensively at elevated temperatures.

Research and development on removal of fine iron oxide aerosols from 1000 F gases reported here is divided into two phases: (1) studies of particle agglomeration by thermal, mechanical devices; and, (2) use of refractory mineral wool fibers for filtration. Successful filtration of iron oxide particles (open hearth furnace fume) has been accomplished in laboratory and field units, and use of rotary agglomerators improves efficiency and extends filter life.

A new cleaning technique for dry filters using blast waves created by exploding diaphragms improves over-all life of the filter. Results of these studies can be applied to effluents from gas turbines, air or gas cooled nuclear reactors, incinerators, boiler flue gases, and many metallurgical processes.

IN EARLIER INSTALLMENTS, the authors discussed fundamentals of agglomeration and methods for increasing it, performance of rotary screw agglomerator, filtration at high temperature, and pilot plants.

Shock Wave Cleaning

It was recognized early in the development of the project that much effort and cost would be saved in full scale designs for open hearth furnaces if the filter could be formed and cleaned in place. This has not previously been successfully accomplished with fiber filters, to our knowledge.

Various methods for *in situ* cleaning are being subjected to laboratory tests. At present the most promising dry method utilizes easily produced shock waves.

It has been found (14) (15) that a low pressure (5 to 10 in. Hg) shock wave will remove up to 90 percent of collected material from fiber filters, in conjunction with blast studies on high efficiency filters. (99.95 percent on 0.3 μ particles).

Material collected on filters was removed without apparent injury to the filters when they were subjected to sub-critical (below damage level) shock waves in laboratory shock tubes (utilizing burst-paper diaphragms) and in field tests of ventilation systems subjected to a shock wave from detonated nuclear weapons. Results of these studies led us to apply this technique to removal of iron oxide fume from slag wool fiber filters.

A shock wave originates with the explosive release of a relatively large amount of energy in a limited space and it travels through the surrounding medium with a velocity greater than the speed of sound in the medium. Actual mass flow of material in the wave is small, and for most low pressure shocks is at relatively low velocity.

For example, with 5 in. Hg shock (2.5 psi) overpressure, velocity of the shock wave is about 1100 fps in air, the "particle" or peak wind velocity is 140 fps (about 95 mph), and dynamic pressure is 0.15 psi (4 in. of water). The combination of the rapidly moving shock wave, the slower moving winds, and the effects of transfer of pressures to stationary objects is called a blast wave.

A blast wave passes through a filter in a very short time. Since

the slag wool filter is 97 percent voids (i.e., free area), it acts as a drag-type structure in considering effects. The degree of blast wave removal of collected material depends upon the length of time the filter is subjected to a positive force, i.e., the length of the "positive phase" of the wave.

Larsen (16), in a basic research project on the forces which hold particles to fibers, has shown that sonic velocities are required to remove small particles from fibers, due to large Van der Waal's forces and surface tension. Filter fibers are relatively fragile and cannot be subjected to multiple handlings before fatigue failure will occur.

A blast wave offers a combination of useful factors for cleaning of fiber filters of the high void volume used here; it has low material velocity; wind speeds are low enough so that relatively little force is transmitted to fibers; and velocity of the pressure wave is at or above sonic, needed to dislodge collected particles.

Equipment Used

Equipment shown in Fig. 8 was used in laboratory studies. It consists of a 6 in. filter holder provided with a small pressure receiver (1.2 cu ft volume) separated from the flow channel by a 6 in. paper diaphragm held between two flanges. A mechanical lance is provided to perforate the diaphragm. For low pressures (5 in. of mercury) onion skin paper is used as a diaphragm and for higher pressures kraft wrapping paper.

Filters are loaded to maximum resistance by previously described aerosol generating techniques (12) and efficiencies are determined before and after blasting.

The filter unit with a plastic tube for visual observation is shown in Fig. 9, taken just before blasting. In Fig. 10 a photograph was taken just when the blast was heard by the photographer. The dispersed fume can be readily seen following the blast wave and settling in the duct.

Oscilloscope tracings have been made on various shock waves utilizing a strain gage diaphragm transducer with high frequency response, as shown in Fig. 11. Peak pressures and time intervals can be measured from these records.

The laboratory apparatus has

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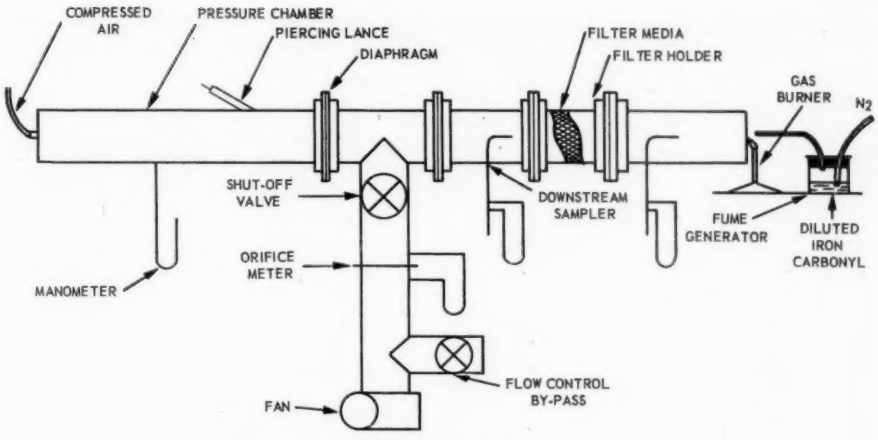

Fig. 8: ***Laboratory shock tube.***

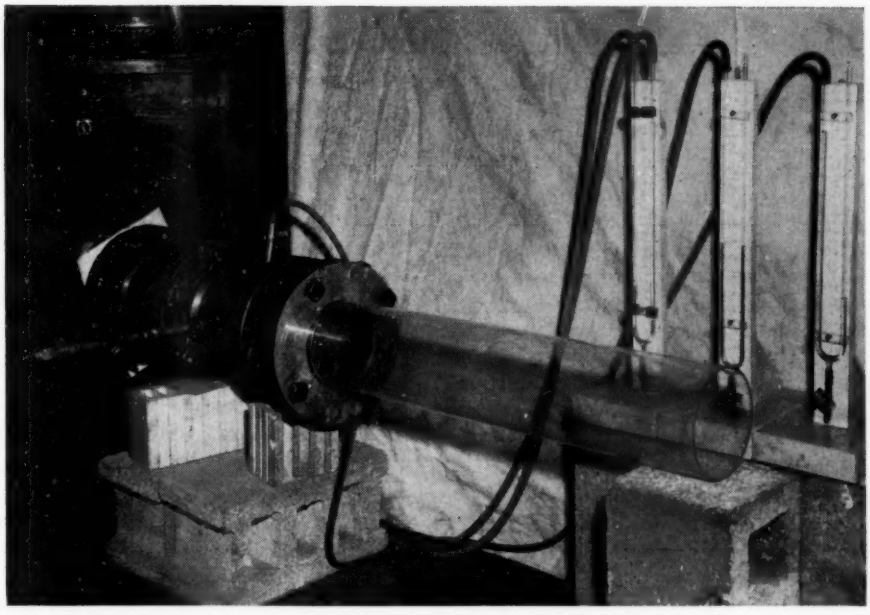

Fig. 9: ***Blast wave filter cleaning apparatus (before blast).***

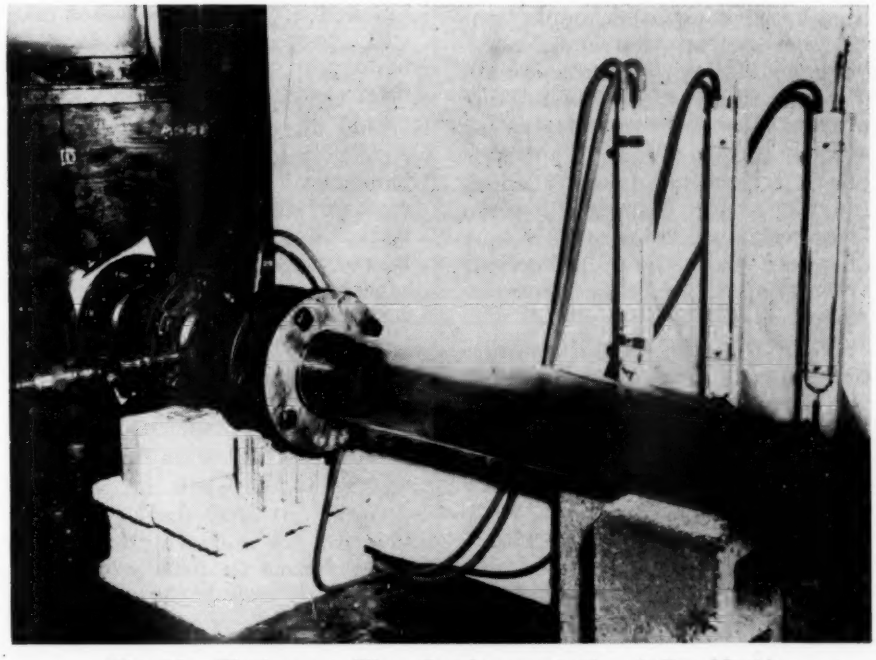

Fig. 10: ***Blast wave filter cleaning apparatus (after blast).***

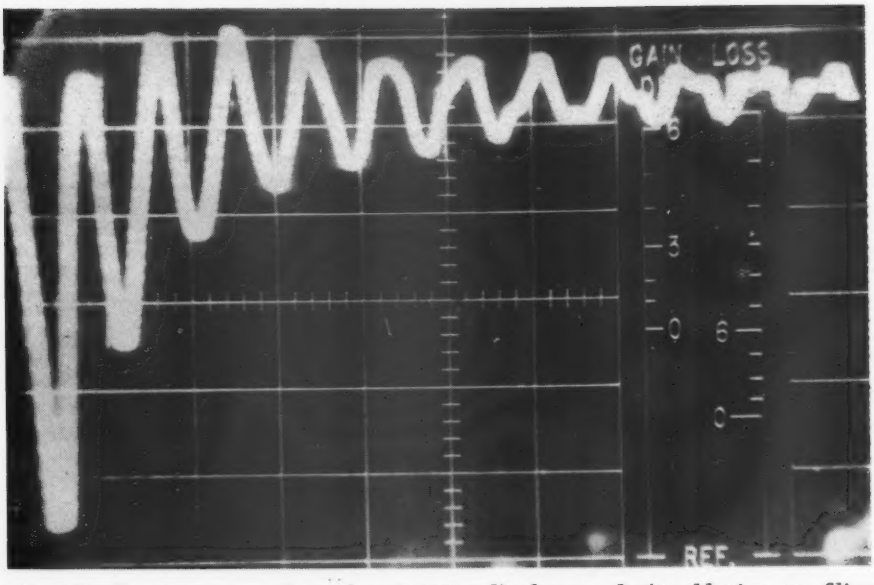

Fig. 11: *Pressure wave from burst paper diaphragm during blast wave filter cleaning. Horizontal grid-20 millisec per major division. Vertical grid-0.62 in. Hg per major division. Location between diaphragm and filter. Blast-5 in. Hg. Volume-0.54 cu. ft. (Positive pressure downward).*

(Continued from preceding page)

given the necessary information on pressure and chamber volumes for pilot plant design. Various size diaphragms have been used to determine how much constriction we could utilize on the initial shock diaphragm to meet space needs. An intermediate size 18 in. filter was evaluated to give better scale values for estimating factors for our 5 ft. pilot unit.

Test Results

Mineral wool filters loaded with laboratory iron oxide fume simulant were cleaned successfully with 5 to 10 in. Hg blast waves generated by bursting paper diaphragms between the test filter and a reservoir containing compressed air. Various ratios of filter and diaphragm diameters were tested.

A 6 in. diameter diaphragm burst in a 6 in. diameter shock tube (filter 6 in. diameter) lowered filter resistance from 8.0 to 4.4 in. of water when the full reservoir volume of 1.22 cu. ft. was employed.

When the diameter of the diaphragm was reduced to 2.3 in. it was found necessary to increase the blast pressure to 10 in. Hg to achieve comparable reduction in filter resistance (from 8.1 to 4.9 in. water). The net decrease (average Δp) was 3.6 in. water with 6 in. diaphragm and 3.2 in. with the 2.3 in. diaphragm at twice the initial pressure.

It is reasonable to conclude from the above summary that optimum cleaning is obtained when blast diaphragm and filter are of the same size. When diaphragm area is reduced, blast over-pressure must be increased somewhat to yield the same amount of resistance decrease, or "cleaning". Permanent filter weight loss appears to be directly related to degree of cleaning.

One test series was run with an 18 in. diameter filter and a 6 in. diaphragm (increase of 9 to 1 in area), and it was found necessary to use 10 in. Hg blast over-pressure to give acceptable cleaning. This latter test represents a more realistic picture of what will be attempted in pilot plant studies presently proposed, i.e., a 2 to 4 in. buildup in resistance, followed by blast cleaning.

One filter was tested with 0.44 cu. ft. reservoir capacity for 43 blasts and maintained very good removal efficiency. It was then tested four times with the 1.22 cu. ft. reservoir and had continued acceptable operating efficiency and resistance decrease upon blasting.

Limited tests with 3 lb. per cu. ft. packing density filters indicated that filter life was generally shorter (before efficiency began to decrease to unacceptable levels) as a result of the blast.

Optimum filter-shock combination for the laboratory unit was 5 lbs. per cu. ft. density on a 6 in. filter with a 6 in. diaphragm at 5 in. Hg over-pressure. A 2.3 in. diameter diaphragm does equally well at higher pressure. Volumes of reservoir greater than 0.7 cu. ft. make little difference in the degree of cleaning.

Conclusions

The shock wave filter cleaning method presents a novel approach to the problem of continuously cleaning a deep bed filter for use on high dust concentrations.

For example, the Kling-Weidlein technique using steel wool filter mats for cleaning blast furnace gas (17) provided mechanical shaking for dust removal. They were not used on a large scale because of resistance problems since the shaking was not completely effective. They could now presumably be aided by addition of shock-wave cleaning.

Another interesting aspect of shock cleaning lies in the ability to examine material that has been removed. Anderson (18) in 1934 suggested the use of filters as agglomerators for liquid particles. To our knowledge there has not been an experimental verification of this suggestion, for solid particles. We have examined particles removed from filter fibers by the action of a blast wave and find that they are highly agglomerated.

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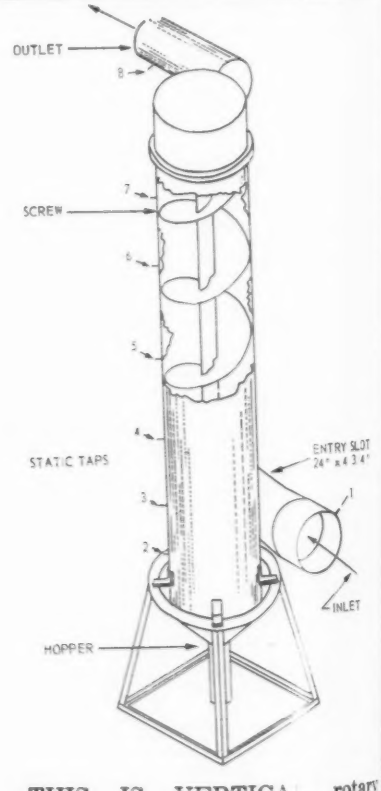

THIS IS VERTICAL rotary screw agglomerator designed for fume removal at high temperature described as Fig. 2 in August instalment. The wrong picture was inadvertently used in that issue.

If Beryllium comes to your plant . . . PART III

Techniques for Control of Beryllium Dust

Beryllium dust presents tough dust control, ventilation and air pollution problems. This series of articles offers valuable data in control methods for air engineers.

by W. B. Harris, A. J. Breslin, *Health and Safety Laboratory*, and Merrill Eisenbud, *New York Operations Office*, *Atomic Energy Commission*

IN PREVIOUS INSTALMENTS, the authors described beryllium dust collection techniques used in a study of atmospheric contamination at Lorain, Ohio. Out of this study the present maximum allowable concentration was determined. How this MAC can be calculated is outlined here.

In Fig. 7 we have shown the relation of averages of data observed during the ten-week test period to calculated curves based on the two theoretic treatments as before. Fixed samplers operating continuously provided measurements for each 24-hour period, and the averages of these measurements are plotted as squares. The triangles represent the average data standardized to equal frequency of all wind directions. The 7000 ft. test datum is an average of three weeks of continuous data within the ten-week test period.

Following the procedure described earlier, two calculated curves are shown for each of three turbulence conditions. The third condition, little turbulence, appears since night data are also included. All curves are based on the assumption of equal frequency of all wind directions and are calculated for a wind speed of 10 mph, the average during the period of test. As before, each curve represents the sum of two curves, for 185 and 33 ft. effluents.

The agreement between theory and observation is similar to that in the two preceding cases. From this we can conclude that for the ten-week test period, the average concentration of beryllium at the ¾ mile radius ranged between 0.004 and 0.02 microgram per cubic meter. This range, which is obtained from Fig. 7, is based on the assumption of equal frequency of wind direction and an average wind speed of 10 mph. Wind conditions during the test were not significantly different from this assumption. We believe, therefore, that 0.01 microgram per cubic meter is a satisfactory approximation of the average ¾ mile concentration during our period of study.

It appears from the case histories that all the affected persons resided within the ¾ mile radius for some period prior to 1946. We believe that during this time, allowing for greater production and greater roof level effluent as discussed earlier, the concentrations were uniformly greater by a factor of something less than 10. It may therefore be concluded that the lowest concentration which produced disease was greater than 0.01 microgram per cubic meter, and probably less than 0.10 microgram per cubic meter.

Using these estimates, the maximum permissible neighborhood concentration has been set at 0.01 microgram per cubic meter, averaged over a full month. Because of the nature of the plant and its equipment, it was uneconomical to modify the plant in its location to the point where this level could be assured. In addition, the location of the plant in a population center was considered to be undesirable even if such a reduction could be assured.

It was therefore decided that a new plant be constructed in an area having a much smaller population density. Prior to the construction of this new plant, however, serious consideration had to

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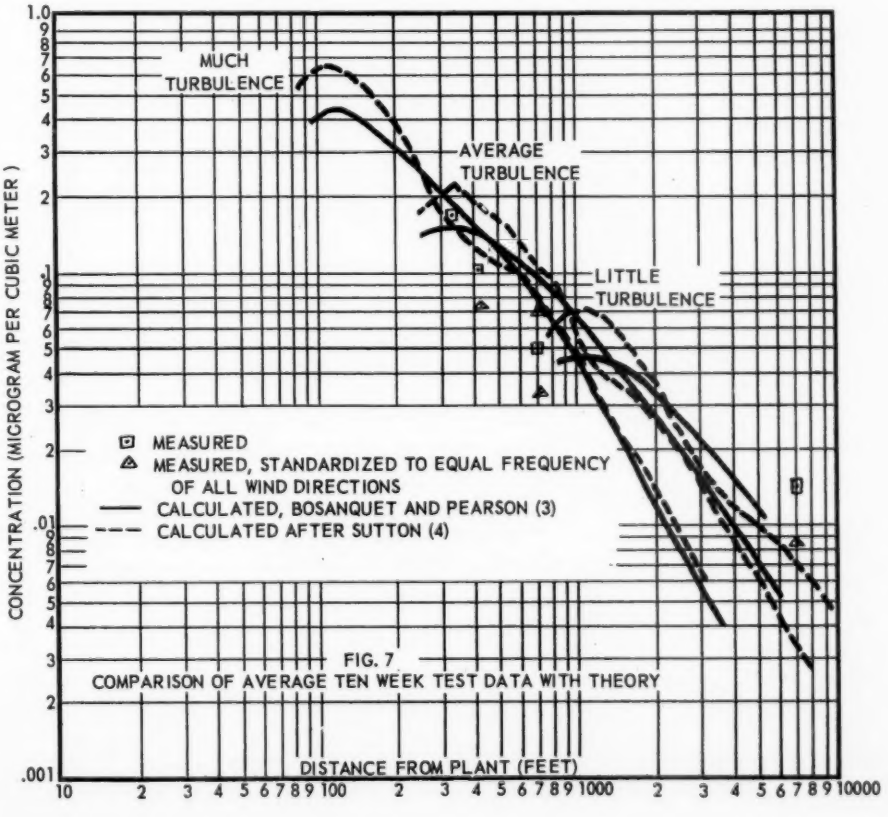


FIG. 7
COMPARISON OF AVERAGE TEN WEEK TEST DATA WITH THEORY

TABLE VI—PLANT DESIGN FOR ATMOSPHERIC POLLUTION CONTROL

Process	*Modification*	*% Effy.*	*—Before— g/day input*	*g/day output*	*After g/day output*
			(5800)		
Ore Handling	Eliminate Crusher	100	4200	300	0.0
Beryl Furnace	Scrubber	85	7.5		1.1
			(33)		
Frit Handling (with ore)	Cloth Arrester	99	1633	2.5	16
		(80 × 99)			
Classifier	Cyclone followed by Cloth Arrester	99	?		3.2
Sulfating Step	Scrubber	95	250	125	12.5
Hydroxide Step	Rotary to Batch, Cyclone and Scrubber	(90 + 70 + 80) 99	2650	1770	26.5
Fluoride Condenser	Cottrell	99	550	42	5
Fluoride Furnace	Scrubber	95	550	550	27.5
Wet Metal	Scrubber	95	50	50	2.5
Metal Furnace	Cloth Arrester	99	350	330	3.5
	TOTAL		10,240.5	3169.5	97.8

(Continued from preceding page)

be given to the inclusion in plant designs of adequate air cleaning equipment to insure that the maximum permissible concentration in the environs of the plant would never be exceeded. Accordingly, it was necessary to establish a permissible level of total plant effluent consistent with attainable engineering designs, and which would prevent excessive ground level contamination.

In the following calculations is shown how one may establish the maximum rate of beryllium emission from the plant stack. These calculations have been carried through using diffusion parameters both for high turbulence which simulates conditions as they were more usual in the original plant, and for conditions of low turbulence which were expected to prevail at the new plant site.

Determination of Maximum Permissible Effluent

For $Co_{max} = 0.01\ \mu g/M^3$

$$\text{Using } \frac{H}{2P} = X_{max}$$

$$\frac{7.5 \times 10^9\ Q}{U\ H^2} \frac{p}{q} = Co_{max}$$

Where:

H = Stack height (feet)

Q = Mass rate of emission (kg/sec)

U = Wind speed (ft/sec)

X_{max} = Distance to maximum (ft)

Co_{max} = Concentration at maximum distance ($\mu g/M^3$)

High Turbulence Condition

$$P = 0.07 \quad \frac{p}{q} = 0.6$$

$$U = 24 \text{ f/s (18 mph)}$$

$$Q = \frac{UH^2}{7.5 \times 10^9} \frac{Co}{p} \frac{q}{} =$$

$$\frac{24 \times 185^2 \times 0.01}{7.5 \times 10^9} \times 1.67$$

$$= 180 \times 10^{-6} \text{ kg/sec} = 155 \text{ g/24 hours}$$

$$X_{max} = \frac{185}{2\ (0.07)} = 1300 \text{ ft.}$$

Low Turbulence Condition

$$P = 0.02 \quad \frac{p}{q} = 0.2 \quad U = 12 \text{ f/s}$$

$$Q = \frac{12 \times 185^2 \times 0.01}{7.5 \times 10^9} \times 5$$

$$= 250 \text{ g/24 hrs.}$$

$$X_{max} = \frac{185}{2\ (0.02)} = 4600 \text{ ft.}$$

As can be seen when a stack height of 185 ft. is used, the plant effluent must be controlled to less than 150 grams per day to insure that maximum ground level concentrations will not exceed 0.1 $\mu g/M^3$ under the most adverse meteorologic conditions.

With this as a starting point and the known effluents of the original plant, Table VI was prepared. From this table it can be seen that the sum of all of the collector intakes can be predicted to be approximately 10 Kg/day. With the type and extent of air cleaning equipment provided in the old plant, this concentration was reduced to approximately 3 Kg/day.

On the basis of the composition of the effluents and the inlet loading of each collector, air cleaning equipment was chosen which would provide a satisfactory degree of contamination. For the purposes of choice, the following assumptions which were based on plant experience were made:

1. Cloth type dust collectors could provide an average efficiency of 99 percent.

2. Wet scrubbing equipment to remove soluble materials could be expected to yield efficiencies of 95 percent.

3. Wet scrubbing equipment on other materials will yield efficiencies of 85 percent when used following centrifugal collectors.

The predicted discharge summed up to a total of approximately 100 gms/day contained beryllium. The plant was constructed and the necessary exhaust systems installed to maintain the concentration in the working atmosphere below the permissible occupation level of 2 $\mu g/M^3$. Each exhaust system was filtered through the equipment which had been specified (See Table VI) and the discharge of all collectors and all systems was brought together in a single stack, the top of which was 185 ft. above grade.

During the course of the first two years of operation of the plant, frequent duct samples were taken to assure design efficiency of the collection equipment. Composite stack samples were obtained on a continuous basis in order that the maximum rate of plant emission could be established. Over this two-year period, the effluent varied between about 80-140 grams per day with an average of about 125. In a like manner, permanent sampling stations were located in a single wind direction from the plant. Stations were located at 1500, 2500, and 5000 ft., all in a due southerly direction. These samplers were operated 24 hours a day and each sample was collected for approximately 72 hours.

In order to assure that the data which were being collected truly represented the concentration at the ground, wind directions were obtained on an hourly basis and cumulated monthly.

From an eight-point wind rose,

the percentage of the time represented by the southerly direction was determined and the concentration adjusted to the direction of maximum winds. This permitted calculation of the maximum ground level concentration in the area of the plant, providing some factor of safety with regard to the average.

Maximum Concentration Between 2,500-5,000 Ft.

Results show that the average maximum concentration occurred somewhere between 2,500 and 5,000 ft., with about 80 percent of the data showing a maximum at 2,500 and the remainder at the 5,000 ft. station. In Fig. 8 is plotted the results of the cumulated data for a two-year period. The first portion of the curve indicates background showing the results of samples taken prior to plant operation. An interim period is shown during which time the operation was partial. The rest of the data represents maximum plant operation. As can be seen from these figures, the calculations show a striking validation of the original calculations. The adjusted curve is in all cases less than 0.01 and in most cases above 0.001. This is within the prognosis. ▲▲

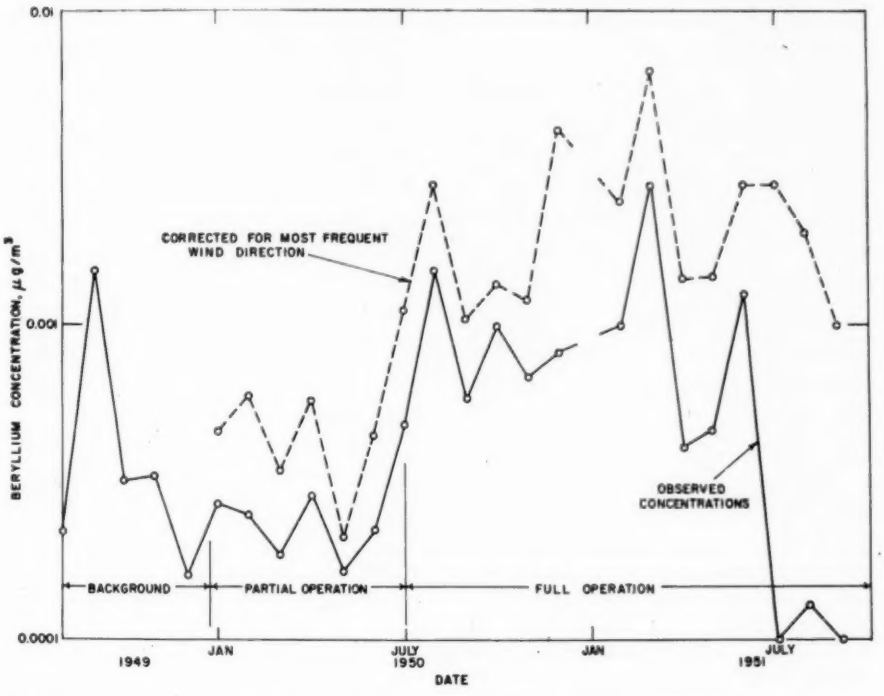


Fig. 8: *Actual observations of air samples over a two-year period provided validation for previous calculations.*

How To Design Dust Control Systems

(Continued from page 27)

collected; and the range of dust particle size and its specific gravity.

The filtration velocity used with intermittent type collectors will vary with specific problems of average nature in the range from 2 to 4 lineal fpm. This is more commonly termed "ratio," meaning 2 to 4 cfm passing each square foot of filtering area. With continuous type collectors, the "ratio," or filtration velocity, is frequently increased.

High dust loadings are reduced by pre-settling devices installed ahead of the cloth filter. This pre-settling is accomplished by a centrifugal or cyclone collector, settling or baffle chamber, or other devices.

The exhauster, or fan, maintains air flow through the exhaust system. The exhauster size is determined by the total air volume to be handled and the total resistance of the system.

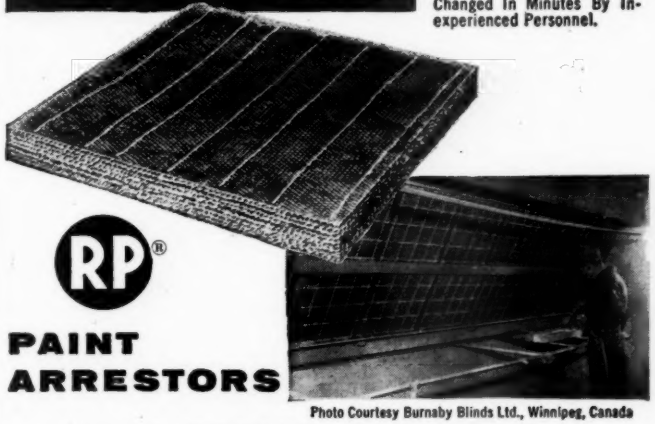
The air volume is the sum of the volumes exhausted from the hoods, usually plus a 10 percent allowance for system leakages. The total resistance of the system is the sum of (a) hood entrance loss, (b) maximum velocity head, (c) frictional resistance of the most resistant branch including bends and entrance into main, (d) frictional resistance of main exhaust pipe, (e) collector resistance including entrance and discharge losses, (f) frictional resistance of exhauster inlet and discharge piping.

(Please turn to page 51)

FICTION FACT

FICTION: Paint Overspray Control Requires Complicated and Expensive Maintenance Procedure.

FACT: An RP Paint Arrestor Equipped Booth Can Be Changed In Minutes By Inexperienced Personnel.



RP® PAINT ARRESTORS

Photo Courtesy Burnaby Blinds Ltd., Winnipeg, Canada

Inexpensive R P Paint Arrestors are easily replaced in a short time to provide like-new paint overspray removal efficiency, with minimum down-time, at a fraction of usual maintenance costs. Economical original installation, too—and adaptable to almost every type operation, R P Paint Arrestors can cut costs, increase production in your booths, too. Write for information.

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Research Promises

(Continued from page 46)

Electron microscope samples (×30,000) indicate that our initial laboratory simulant fume generated from combustion of iron penta-carbonyl ($Fe(CO)_5$) has a particle size of 0.056μ (CMD). Fume blasted from the filter has an average size of 0.096μ (CMD). This demonstrates that significant agglomeration takes place on filter fibers. A filter can therefore be used as an agglomerator if material collected can be redispersed, and shock wave treatment seems more than adequate to do this.

Progress on the Harvard-AISI project for control of air pollution from high temperature waste gases is presented. Past and present developments on agglomeration methods for increasing particle size include creation of a new instrument for observing particle growth, and evaluation of a simple mechanical-thermal device for particle aggregation and gas cooling.

Filtration studies have progressed through development of four pilot plants with extended field studies completed on two units. Present pilot plant development provides a universal type unit eliminating mechanical seals. This unit permits wet and dry cleaning methods to be explored on a larger scale than in the laboratory.

Slag wool economy studies indicate the possibility of extending fiber life as much as 20 times over that found in previous studies. This paper presents some results of blast wave cleaning of dry filters in place utilizing shock waves created by simple exploded paper diaphragms.

Cleaning efficiency of the filter is not significantly impaired by this treatment and it has permitted resistance control. Some typical data are presented. Dry cleaning of wool by shock treatment and possibly by back washing may greatly reduce the cost of gas cleaning by the slag wool method.

Agglomeration studies indicate that filter life may also be extended by particle aggregation. ▲▲

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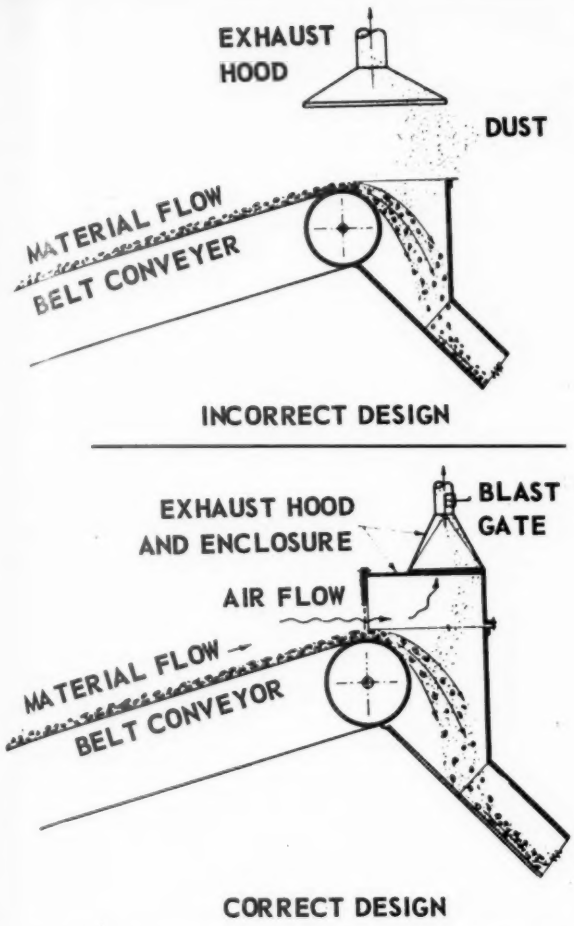


Fig. 6: *Typical example of correct and incorrect exhaust hood design.*

How To Design Dust Control Systems

(Continued from page 49)

Exhausters of the steel plate radial blade type are most commonly used for exhaust systems.

Suction Type Installation

In suction type installations, particularly when using cloth filters with the exhauster handling cleaned air, higher efficiency fans similar to those for ventilating work are used, the more common designs being the airfoil blade type and the backward curved blade, or high speed type. While these exhausters are similar in design to those used in ventilating and air conditioning work, they are usually of heavier construction for exhaust system application because of the higher pressures required.

Exhauster Drives

Exhausters are driven by motors, either direct connected or through chain or multiple vee belt drive. The multiple vee belt drive predominates because of low initial cost, minimum slip with short centers, and flexibility for speed change.

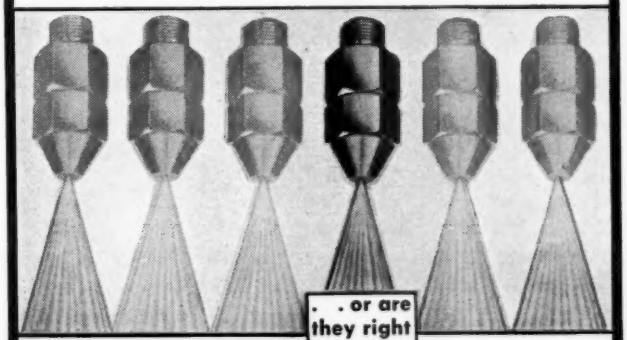
Direct driven exhausters are not advocated for industrial exhaust system applications since it is generally difficult to select a fan for a specific requirement with an operating speed which coincides with standard motor speeds. Direct driven exhausters consequently, in many instances, require special wheel proportions to produce required performance, often at some sacrifice in efficiency. There is the further disadvantage in that any change in system operating requirement (air volume or pressure), which would require a change in fan speed readily obtained with belt drive, necessitates a new special wheel or conversion of the fan to belt drive.

The above discussion of the elements of industrial dust control systems provides a basis from which to pursue the details of system design. It is always a good idea, however, to consult with manufacturers of industrial dust control equipment. These firms are qualified by experience to help plan overall systems and advise on the specific problems of each case.

Correctly designed systems pay their own way both in tangible and intangible savings. Collected waste, better workmanship, unsoiled finished products, greater visibility within the plant, less frequent painting, and longer life of operating equipment are all specific savings credited to dust control equipment.

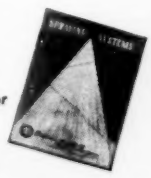
In plants where dust is salvageable or hazardous, these potential savings are obvious. It is in the plants where dust is considered only a nuisance that management sometimes doesn't realize that uncontrolled dust usually costs a great deal more to ignore than it does to control it. ▲▲

Are the SPRAY NOZZLES you use in the grey zones . . .



. . or are they right on the beam?

Like an electronic system, a spray nozzle system can be *tuned* for maximum performance. To do this select spray nozzles that *exactly* fit the system needs . . . in terms of capacity, spray characteristics and materials. The use of Spraying Systems spray nozzles keeps spraying installations out of the costly grey zones. The reason: you have a choice of over 12,000 *standard* nozzle types and capacities to match the nozzles exactly to your need.



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irritants.[7] Odor control using suitable catalyst equipment of special design [8] has recently been tested for rendering exhaust vapors. Here it is reported most objectionable odors were removed at temperatures considerably lower than would be required by other forms of combustion.

It is granted that the use of a catalyst whether it be as a platinum alloy activated alumina coating on porcelain rods, or on nichrome wire, or platinum-pallablium coating must have exacting conditions of use before they can be effective.

Catalysts Valuable

Nevertheless, when used properly they are valuable for the purpose of odor elimination, and should be included, we feel, as part of this third group (chemical reactants).

By accepted definition, a catalyst is a substance which will alter the rate of a chemical reaction without itself becoming a part of the end product, or undergoing a permanent change.

Specific treatments involving chemical reactions perhaps fall into the following methods: oxidation, alkalization, polymerization, acidification, etc.

Most of these are used at an early stage in processing where definite measurement may be possible. Limitations exist in their application in late stages or after a malodorous material reaches the atmosphere.

Here we believe is a field for study. That is, to take such chemical reactants if possible and put them to work within the atmosphere itself to clean up, clear, and eliminate an objectionable odor or odor groups.

It is our belief that this is possible. We hope in the not too distant future to provide such a new tool toward odor elimination of some odorous compounds. In fact, our work has uncovered a material which is available for experimental purposes [9].

Our work has resulted in designing a product which showed its catalytic effectiveness in its introduction in the form of liquid scrubbing of gas mixtures. Here the catalytic material was incorporated in dilution in ethyl alcohol.

Hydrogen sulfide and oxygen were introduce in the gas phase. Temperatures were thermostated at 70 C and the H_2S concentrations going into and coming out of the reaction chamber were measured by titration.

Following this development work we proceeded to conduct tests under a laboratory designed stack to more closely resemble actual mill stack gas conditions, and they confirmed the scrubbing tests. Here, known quantities of the catalytic material were sprayed concurrently into the gas stream at the bottom of the stack.

At temperatures around 70 C, with adjusted H_2S and carbon dioxide values to resemble mill conditions, appreciable reduction of H_2S concentration at the exhaust end confirmed the previous results.

Equipped with this intelligence actual mill trials have been made with gas volumes of 60-120,000 cfm with mixed sulphides in the range of 200-2000 ppm. Good odor control results were obtained. The concentration of the catalyst was in the range of 34 ppm. Analytical data supported the absence of the usual strong odors over a 20-hour period.

We hope this type of odor control using aqueous systems and sprayed into the airborne gases themselves will continue to prove itself, and that commercial application will soon be desirable. Much work is still to be done and we are proceeding as rapidly as possible.

Using Absorption Products

The fourth group is absorption products. Of many products perhaps activated carbon is one of the best. It has generally high capacity for retaining at least 15-20 percent of its weight of a pollutant. It differs from Silica-gel or Acticated Alumina in that it is nonpolar.

Thus, the presence of moisture in the polluted air is not likely to affect its use. While it absorbs many odors under most conditions such odors themselves can reduce its efficiency soon after use.

In fact, we have treated newly activated cell beds with designed reodorants [10] to provide a further degree of odor control.

It has been observed by Turk [11] that the upper practical range for activated carbon application (2 to 5 ppm) is far below the lower practical range for catalytic combustion, (1000-1500 ppm) and that this void has been stressed in current literature.

A great number of industrial plant stack exhausts emit odors in quantities between these two ranges. Thus, it may be necessary in some cases to not only employ absorption but other forms of odor control, such as masking and catalytic combustion, to meet all requirements.

One of the very best sources for study of odor control by absorption comes from the Market Data Section, *Chemical Engineering*, August 1957 [1].

In conclusion, I hope I have brought to you some answers toward the use of odor control products. You can abate some malodors successfully, and it is possible in some cases to eliminate objectionable odors. ▲▲

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